SOUTH DAKOTA BOARD OF NURSING
SOUTH DAKOTA DEPARTMENT OF HEALTH
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SOUTH DAKOTA BOARD OF NURSING

LPN COURSE FOR INITIATION AND ADMINISTRATION OF INTRAVENOUS THERAPY

in cooperation with

Lake Area Technical Institute

Southeast Technical Institute

Western Dakota Technical Institute

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CENTER FOR NURSING WORKFORCE

LPN Course for Initiation and Administration of Intravenous Therapy

In July 2000, Administrative Rules of South Dakota were changed to incorporate the functions of initiation and administration of IV therapy into the basic role of the Licensed Practical Nurse. As of 2001, students of LPN programs in South Dakota have these skills upon graduation.

LPNs who graduated prior to 2001 and who have not been trained in the initiation and administration of IV therapy do not have these skills within their scope of practice, and so must obtain the knowledge and skills prior to the performance of IV therapy functions.

Syllabus:

Purpose: The purpose of this course is to serve as the educational basis to prepare LPNs educated prior to 2001 in the performance of IV therapy functions in accordance with SDCL 36-9-1.1, 36-9-4.1 and ARSD 20:48:04:06.

Expected Outcomes: It is expected that completion of this course will:

1. Enhance knowledge of established IV nursing standards of practice
2. Qualify the LPN to initiate and administer IV therapy to adults and adolescents

Course Requirements: Each student must be currently licensed as a LPN in South Dakota. Total course content delivery will include didactic and competency skill examinations. Course content will be delivered in sessions compatible with instructor and student schedules. Students will be required to complete a written examination over course content with a minimum of 85% accuracy. Should the student not attain this level of mastery, the examination may be retaken once without penalty. Should any student fail to achieve mastery with the second examination, they will be required to retake the entire course. Students will also be required to successfully master a clinical demonstration of selected IV therapy competencies on a pass/fail basis. The instructor, upon the student's successful completion of the course requirements, will issue a certificate of completion.

Clinical Component: After successful mastery of course content, each student will complete a check off competency within their facility for initiation and administration of IV therapy under the direct supervision of a registered nurse. The Board of Nursing no longer issues an expanded role certificate designation for IV therapy.

Education Principles: Instruction of the course content will be based on the following tenets of educational theory:

a. learning is a process by which a change in behavior occurs in an individual
b. the change may be evident in three domains:
    1. cognitive = increased knowledge/understanding
    2. psychomotor = skill enhancement
    3. affective = change in attitude
c. learning occurs when an individual identifies a need to know something or to gain the ability to do something

Course content will be taught also with principles of adult learning as the background. The LPN enrolling in the course will come to class with a variety of experiences, clinical expertise, and motivations, i.e., desire to enhance job satisfaction, advance their nursing practice, achieve personal growth, and/or enhance employment opportunities.

Instructional Methods: Course content will be covered via the following methods:

a. lecture/discussion
b. overhead transparencies
c. audiovisual materials
d. printed handouts
e. clinical demonstrations

Evaluation Methods:

a. written examinations over unit contents
b. clinical demonstrations, competency checklist
c. student evaluation of course/ instructor/ instructional materials
d. student self-evaluation

Concepts/Principles applied in Course Content:

a. intravenous therapy assessment skills
b. principles of aseptic techniques
c. principles of pharmacology
d. clinical mathematics
e. patient education
f. principles of anatomy and physiology related to IV therapy
g. principles of intravenous fluid administration

LPN UNIT OBJECTIVES FOR INTRAVENOUS FLUID THERAPY MODULE

After completing the following units, the student should be able to:

Unit I. LEGALITIES

1. Understand parameters for LPN Scope of Practice in accordance with SDCL 36-9-1.1, 36-9-4.1 and ARSD 20:48:04:06.
2. Discuss nursing ethics and patient rights as applied to intravenous fluid therapy
3. Identify the role of the registered nurse and in the performance of IV Therapy.

Unit II. PATIENT EDUCATION PRINCIPLES

1. Identify the essential elements when educating patients regarding the initiation and administration of intravenous therapy.

Unit III. FLUID AND ELECTROLYTES

1. Discuss hydration and normal fluid balance.
2. Describe regulatory factors that maintain fluid balance.
3. Identify selected disturbances in regulatory factors that maintain fluid balance.
4. State nursing responsibilities and interventions regarding regulatory factors in fluid balance.
5. Identify definitions of terms associated with dehydration and fluid overload.
6. State nursing responsibilities and interventions regarding possible dehydration.

Unit IV. ANATOMY AND PHYSIOLOGY

1. Discuss the physiology of the cardiopulmonary system, distinguishing between pathophysiological conditions and normal conditions.
2. Describe physiology, anatomy and circulation of the venous system.
3. Describe pathophysiological conditions of the venous system.
4. Identify the skin layers.
5. Trace the flow of blood through the heart.

Unit V. EQUIPMENT USED IN INTRAVENOUS THERAPY

1. Distinguish among characteristics of:
    a. IV solution containers
    b. IV tubings (macro-micro drip)
    c. Secondary ports
    d. Vented/non-vented tubing
    e. Clamps/terminal filtering devices
    f. IV needles/catheters
    g. Electronic controlling devices

Unit VI. IV THERAPY

1. State nursing interventions with regard to splints/restraints.
2. Calculate flow rates.
3. State instructions about IV therapy to be given to the patient.
4. State nursing interventions with regard to initiation, monitoring and discontinuation of the peripheral IV system.
5. Distinguish among factors necessary for appropriate documentation of the initiation, maintenance and ongoing monitoring of IV therapy.

6. Identify specific considerations related to the administration of IV therapy via peripheral and central lines.
7. Demonstrate the ability to:
    a. perform daily care for IV site and tubing, peripheral and central
    b. replace IV tubing
    c. discontinue peripheral IV
    d. remove air from tubing via various methods
    e. perform venipuncture for the purpose of initiating IV therapy

Unit VII. SPECIAL APPLICATIONS

1. Describe the process of inflammation and its affect on the body.
2. Describe principles of infection control in relationship to IV fluid therapy initiation and administration.
3. Identify specific considerations for the initiation and administration of IV fluids to the geriatric patient.

Unit VIII. POTENTIAL INTRAVENOUS THERAPY COMPLICATIONS

1. Perform proper nursing interventions related to management of the IV complications including:
    a. hematoma
    b. thrombus formation
    c. infiltration
    d. phlebitis
    e. emboli
    f. fluid overload
    g. speed shock
2. Distinguish between specific considerations related to local and systemic IV therapy reactions
3. Demonstrate the ability to:
    a. confirm placement and patency of ONC, wing tipped, heparin lock needle
    b. establish prescribed flow rate

Unit IX. PHARMACOLOGY

1. Identify the purpose of intravenous drug therapy.
2. Discuss the five “rights” of medication administration.
3. List essential elements the nurse must obtain prior to IV medication administration.
4. Identify medical information to be obtained in a nursing history.
5. Distinguish among methods of administering IV medications and their appropriate guidelines.
6. State nursing responsibilities and interventions with regard to the administration of IV medications.
7. Discuss considerations and interventions concerning IV drug compatibilities.
8. Use reference sources to determine incompatibilities and appropriate nursing actions for IV administration of drugs.
9. Demonstrate the ability to:
    a. schedule the administration of drugs
    b. administer medications using the:
        1. piggyback method
        2. continuous infusion method
        3. heparin lock flush method.

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I. South Dakota Legislation and Standards of Practice for IV Therapy

A. South Dakota Codified Law 36-9-1.1, 36-9-4.1 governing the Nurse Practice Act. Chapter 20:48:04:06 speaks specifically to the role of the Licensed Practical Nurse in IV Therapy. The functions allowed by law are:

(1) Peripheral intravenous therapy to adults and adolescents, as follows:

(a) Perform venipuncture to administer intravenous fluids in peripheral veins, excluding midline catheters;

(b) Assemble and maintain equipment for:

(i) Gravity drip infusion; and

(ii) Electronic controlling devices, excluding client-controlled devices;

(c) Calculate and adjust infusion rates using standard formulas;

(d) Perform routine intravenous tubing set changes;

(e) Administer, by peripheral route, standard solutions at a defined flow rate, with or without admixtures, mixed and labeled by a pharmacist, registered nurse, or physician. The admixture, potassium chloride, may not be administered at a concentration that exceeds 20 meq/liter or at a rate that exceeds 10 meq/hour;

(f) Administer vitamins, antibiotics, corticosteroids, and H2 antagonists by the intravenous piggyback route, that are mixed and labeled by a pharmacist, registered nurse, or physician, excluding the first dose which must be administered by a registered nurse;

(g) Convert and flush heparin or saline intermittent infusion devices;

(h) Perform routine intravenous site dressing changes;

(i) Discontinue peripheral intravenous therapy, excluding midline catheters;

(2) Intravenous therapy via an externally accessed centrally placed catheter to adults and adolescents, as follows:

(a) Assemble and maintain equipment for:

(i) Gravity drip infusion; and

(ii) Electronic controlling devices, excluding client-controlled devices;

(b) Calculate and adjust infusion rates using standard formulas;

(c) Perform routine intravenous tubing set changes;

(d) Administer standard solutions at a defined flow rate, with or without admixtures, mixed and labeled by a pharmacist, registered nurse, or physician. The admixture, potassium chloride, may not be administered at a concentration that exceeds 20 meq/liter or at a rate that exceeds 10 meq/hour;

(e) Administer vitamins, antibiotics, corticosteroids, and H2 antagonists by the intravenous piggyback route, that are mixed and labeled by a pharmacist, registered nurse, or physician, excluding the first dose which must be administered by a registered nurse;

(f) Perform routine heparin or saline flushes; and

(g) Perform central line dressing changes.

However, LPNs performing IV Therapy functions in states other than South Dakota should consult the particular state's rules and regulations for further direction and/or limitations.

B. Standards that the nurse must follow. (Policies may vary from institution to institution)

1. Nurse must accept responsibility for obtaining and knowing the institution's policies and procedures regarding IV therapy.
2. Institutions may require evidence of specific training.

II. Nursing Ethics and Patient Rights as Applied to IV Therapy
   A. Nursing Ethics: Each Nurse Must Be:
      1. Responsible for her/his own actions.
      2. Aware of self-limitations and never endanger a patient.
   B. Patient Rights
      1. Patients have the right to refuse any or all treatment and therapy.
      2. Patients have a right to know the reason for therapy and the expected results.

III. Information to be included in an IV Order:
   A. Solution(s) ordered i.e. D5W
   B. Volume of solution ordered i.e. 1000 ml. or 500 ml.
   C. Amount of time in which a specified vol. of fluid is to infuse i.e. give 1000 ml in 8 hrs; run at 125 cc/hr.
   D. Which solution should be infused first, second, third, etc. i.e. doctor's order could read D5W, D5LR, D51/2NS. D51/2NS would be the third.
   E. Where IV orders are to be written for communication to other nurses i.e. Kardex, IV board, IV flow sheet, medication care.
   F. How orders should be written on communication tool i.e. a doctor's order of "D5W, D5LR, D51/2NS, give 1000 m1 q 8 hrs" would be written on Kardex as follows:
      D5W 1000 m1 8 a.m.
      D5LR 1000 m1 4 p.m.
      D51/2 NS 1000 m1 12 a.m.
   G. Medications added to solution (Registered Nurse function)

Methods of documentation for IV therapy may vary from institution to institution. The following are some areas to consider when documenting IV therapy.

I. Chart forms and information required in documenting monitoring and maintenance of IV therapy
   A. Nurses Notes
      1. Frequency of status check (i.e. IV checked every hour)
      2. Flow rate setting i.e. IV set to run at 100 ml/hr
      3. Volume being delivered i.e. 12 a.m. – IV infusing well, 400 m1 infused as prescribed
      4. Location of insertion site
      5. Lack of complications at site i.e. IV infusing well with no redness, leaking, or swelling
      6. Complications at the site and any interventions for those complications
      7. Systemic-type complications and interventions for those complications
      8. Tolerance by patient and understanding of limitations
      9. Patency of needle or catheter and any interventions carried out
      10. Questions, fears, and/or misinterpretations expressed by patient; our interventions, and patient's understanding of explanation.
   B. Medication or IV sheets and/or I & O sheets
      1. Type and amount of solution hung
      2. Date and time solution hung
      3. Tubing change
      4. Amount of solution left at end of shift
      5. Amount of solution patient received
      6. Urine output either from catheter or voiding
      7. Intake other than IV/output other than urine

UNIT II: PATIENT EDUCATION PRINCIPLES

It is important to keep in mind the following factors when deciding when and how to educate each individual patient regarding intravenous fluid therapy (IVFT).

I. Consider certain aspects of psychological principles in preparation of the patient.

II. Anxiety experienced by patients receiving IVFT is due in part from:
   A. painfulness of therapy especially with freq. cannula insertion
   B. association made with hospitalization (creating stress)
   C. association with underlying illness

III. Illness and/or hospitalization represent a situational crisis for the patient/resident and family.

IV. Patient's mental status and cooperation level must be taken into consideration when beginning IVFT.

V. Type of approach to initiation of IVFT will be influenced as well by whether IVFT will be administered on inpatient/outpatient basis.

VI. Individual's response can be influenced by psychological factors; some patients/residents may view IVFT as an annoyance and uncomfortable procedure; some may not demonstrate overt anxiety and may demonstrate a willingness to cooperate, yet may harbor fears about the prospect of IVFT.

VII. Type of therapy is frequently uncomfortable and sometimes hazardous.

UNIT III: FLUID & ELECTROLYTES LESSON 1: BASIC CONCEPTS

So that the LPN can safely administer basic intravenous solutions and monitor IV therapy, it is necessary to understand some basic concepts in relationship to fluid and electrolytes. These basic concepts explain how fluids and electrolytes are utilized in the body to maintain homeostasis.

1. Body cells constantly bathed in fluid environment (facilitates bringing oxygen and nutrients to the cells and taking the waste products of metabolism away)
2. Although there is a continuous input/output into and from the body, the amount of body fluid at any given moment is constant (fluid homeostasis)
3. Various feedback/control mechanisms assist to maintain this steady state
4. Water is major part of fluid environment; accounts for approximately 45-70% of an adult's body weight (depending on which sources are consulted)

   Functions of body fluids include:

   1. Maintenance of blood volume
   2. Regulation of body temperature
   3. Transportation of materials to and from cells
   4. Acting as a medium for cellular metabolism, including acting as the fluid in which substances necessary for cell function are dissolved
   5. Assistance in food digestion (hydrolysis)

I. Body fluid compartments
   - A. Extracellular fluid compartment composed of:
     1. Interstitial: fluid between the cells
     2. Intravascular: fluid in blood vessel (plasma)
     3. Transcellular: fluid in GI tract, cerebrospinal fluid, intraocular fluid
   - B. Intracellular fluid compartment (approximately 55%) composed of fluid within the cell itself
   - C. Changes in the intracellular and interstitial fluid compartment occur in response to changes in volume or concentration of plasma
   - D. Body fluids are electrically neutral: overall the sum of the positive charges (cations) equals the sum of the negative charges (anions)

II. Composition of body fluids
   - A. Non-electrolytes
     1. Glucose & urea are dissolved in body fluids – do not break apart in solution.
   - B. Electrolytes
     1. Chemical activity is dependent upon the charge of ion: the greater the charge, the greater the chemical activity.
     2. Positive ions = Cations
        Na+ (sodium), K+ (potassium), Ca++ (calcium), Mg+ (magnesium)
     3. Negative ions = Anions
        CL- (chloride), $HC0_3$- (bicarbonate)
     4. Electrolytes function to
        a. maintain body fluid distribution
        b. facilitate neuromuscular impulses
        c. facilitate cellular metabolism
        d. maintain the pH (acid-base) balance

Potassium (K+)	major intracellular fluid cation
	essential for appropriate functioning of: 1. certain biochemical reactions 2. nerve conduction/muscle contraction 3. myocardial membrane functioning 4. acid base balance
Sodium (Na+)	major extracellular fluid cation
	essential for appropriate functioning of: 1. osmotic pressure or extracellular fluid 2. H_2O distribution (influences distribution more than any other electrolyte – NA and H_2O relationship (inseparable) 3. conduction of nerve impulses 4. irritability of nerve and muscle tissue 5. acid base balance
Calcium (Ca++)	human body contains about 1200 grams of calcium; about 99% is tied up in bone
	disturbances in calcium levels exist but are not as prevalent as sodium and potassium imbalances
	adequate/inadequate amounts contribute to development and management of osteoporosis
	parathyroids active in balancing both calcium and phosphorus in the body
Chloride (CL)	assists in maintaining normal extracellular osmotic pressure
	essential for hydrochloride (CL) production by gastric mucosal cells
	buffering for acid base balance b/c CL competes with bicarb for combination with Na
Magnesium (Mg+)	a second major cation of intracellular fluid
	plays significant role in functioning of cellular enzyme systems, certain biochemical reactions, metabolism of glucose, pyruvic acid, ATP
	affects skeletal, cardiac, smooth muscle
	assists with vitamin activation, especially B complex
Phosphate	plays role in intracellular energy producing reactions
	participates in CHO metabolism and maintenance of acid-base balance

Fluid Transport

A. Fluid and solute transport
    1. semi permeable membrane allows certain substances to pass through pores i.e. H20 & H20 soluble substances (urea, chloride)
    2. under normal conditions semi-permeable membrane bars proteins & other colloids from passage
    3. movement of H_20 & solutes between plasma & interstitial fluid made possible by capillary circulation
    4. capillary be must be highly permeable, allowing rapid exchange from plasma to cells & from cells to plasma via interstitial fluid
    5. fluid delivery to interstitial space at arterial end must be recovered at venous end
B. Transport Mechanisms
    1. Diffusion
        a. simple diffusion = random movement of particles in all directions through a solution
        b. molecules move from area of greater concentration to lesser concentration
        c. molecules in constant motion and tend to equalize in any vessel
        d. "facilitated" diffusion occurs when larger molecules such as proteins & sugars are assisted across cell membrane via carrier transport

2. Osmosis
    a. water moves from area of lesser concentration to greater “water follows salt”
    b. Isotonic - fluid has same tonicity as cells = no cell size change
    c. Hypotonic - fluid concentration less than cells (intracellular) so fluid flows into cells causing them to swell
    d. Hypertonic-fluid has greater concentration than intracellular (ICF) so fluid flows out of cell causing them to shrink

C. Osmolality
1. measures number of dissolved particles in solution which alters the concentration & thus change chemical potential of body H_20 (specific gravity of body fluids)
2. normal osmolality of body fluids (ECF/ICF) is 280-294 mOsm/Kg
3. Intracellular & extracellular osmolalities are always equal & their measurement provides information on overall body hydration & concentration of body fluids = water diffuses from low osmolality to high osmolality
4. Isotonic solutions: concentration is very similar to body fluids (i.e. D5W, 0.9% NaCI)
5. Hypertonic solutions: concentration greater than body fluids. Cells shrink in hypertonic solution because water is pulled out of them (i.e. 50% D5W)
6. Hypotonic solutions: less concentrated than body fluids, therefore water will flow into cells causing them to swell and eventually burst (i.e. 45 NaCI)

D. Active Transport
1. moves molecules uphill against a concentration gradient
2. mechanism uses energy in form of ATP & carrier substance to transport Na+, K+, CI-, sugars, amino acids
3. most important example is 'Napump' which maintains conduction & contraction in nerve/muscle cells

E. Filtration
1. transfer of H2O and other dissolved substances across semi-permeable membrane from area of high to low pressure
2. force behind process is hydrostatic pressure produced by pumping action of the heart

III. Fluid Regulation

A. Kidney is primary regulator with lesser contribution from lung/skin
B. Kidney regulates fluid balance through control of extracellular fluid (concentration of electrolytes, regulating osmolality, controlling volume of ECF, blood volume, pH)
C. Depending on circumstances kidneys either selectively rids body of extra H20 & electrolytes or conserves them & returns them to circulation
D. Altered renal function can have a profound effect on F & E balance as would cardiac malfunction where the heart must pump blood to the kidneys under enough pressure to be filtered through
E. Hormonal regulation of fluid balance due in large part to action of aldosterone & ADH
1. Aldosterone
    a. mineralocorticoid secreted by adrenal cortex which influences renal tubules to incr. reabsorption of NA+ in exchange for secreting K+
    b. aldosterone release is stimulated by: high serum K+ levels, hyponatremia, hypovolemia, renin-angiotensin system
    c. overproduction of aldosterone causes NA & H_2O to be retained and K to be excreted; conversely, too little aldosterone causes NA + and H_2O loss and K retention
2. ADH: Anti-Diuretic Hormone
    a. released from post. Pituitary gland (vasopressin)

b. has affinity for renal tubules to reabsorb H_2O back into the circulation
c. secreted to make body retain H_2O-too much ADH secretion means too much H_2O retention and a drop in serum NA levels; too little means excessive water loss
d. release of ADH stimulated by:
    1. high plasma osmolality
    2. low circulating blood volume
    3. pain/emotional stress
    4. certain drugs/chemicals (i.e. morphine, some anesthetics)

IV. Regulation of Acid Base Balance
A. normal metabolism generates H + ions in form of certain types of acids which need to be excreted every day to prevent acidosis
B. largest amount of acid prod. is carbonic (H_2C0_3) readily excreted by lungs as $C0_2$
C. dietary intake of acids and alkalies are also metabolized & then excreted to prevent changes in acid-base balance
D. regulation of H+ content = pH: reflects H + ion concentration
E. blood pH can be maintained in narrow range between 7.35 & 7.45 (more variation in either direction can be potentially fatal)
F. increase in H + ion = acidosis (below 7.35)
G. decrease in H + ion = alkalosis (above 7.45)
H. eventually kidneys attempt to correct metabolic disorders and lungs attempt to correct respiratory disorders; neither are completely successful until underlying disturbance has subsided or been corrected
I. in the body, 3 systems operate to maintain appropriate pH of blood and acid-base balance
    1. Chemical buffer system
        a. Acid-Base buffers immediately combine with any acid or alkali preventing excess changes in H + ion concentration
        b. This system is 1st line defense and responds most quickly to changes in pH sometimes second to second
        c. Metabolic influences on pH are reflected in level of alkali bicarbonate ($HC0_3$), normally 22-26 meq/L; less means metabolic acidosis, more = metabolic alkalosis
        d. pH of plasma maintained by ratio of $NaHC0_3$ & carbonic acid (H_2C0_3)
        e. Body has stronger tendency toward acidity therefore requiring more base buffering systems than acid buffering systems
        f. Ratio of bicarb to carbonic acid is 20:1
        g. $NaHC0_3$-H_2HC0_3 buffer system is responsible for approximately 45% of all H + ion buffering
        h. This value can be assessed clinically by measuring blood gas pH, $pC0_2$ & serum $HC0_3$ concentration or total $C0_2$ content
        i. HCL reacts with $NaHC0_3$ to convert H_2C0_3 which dissociates into $C0_2$ & H_20 with $C0_2$ being eliminated by lungs
    2. Respiratory buffer system
        a. an increase in $C0_2$ plasma lowers pH & decrease in $C0_2$ plasma increases pH
        b. $C0_2$ when broken down $C0_2$ diffuses into lungs & is eliminated by exhalation; rate of alveolar ventilation effects H+ ion concentration of body fluids
        c. An increase in alveolar ventilation blows off more $C0_2$ and raises pH; decrease in alveolar ventilation causes $C0_2$ retention and a decrease in pH

d. Rate of ventilation affects H + ion concentr. but H + ion concentr. also affects rate of ventil. b/c circulation H + ions in the plasma stimulate the respiratory center of medulla oblongata thus increasing ventilation
e. Respiration's effect on pH is indicated by partial pressure of carbon dioxide ($PaC0_2$)
f. $PaC0_2$ normally ranges b/w 35-45 mm Hg; a lower value denotes respiratory alkalosis, a higher one resp. acidosis
g. Respiratory compensation begins almost immediately but may not reach a steady state for 12-24 hrs.

3. Renal buffer system
   a. H + ion concentration can be influenced up or down by series of complex chemical reactions that occur in the renal tubules
   b. This regulation is accomplished by secretion of H+ into tubular & eliminated in urine as H_20 in combination with phosphate or ammonia
   c. Na is reabsorbed from tubular fluid into the extracellular fluid in exchange for H + & combines with bicarb ions to form buffer $NaHC0_3$
   d. $NaHC0_3$ is formed in the extacellular fluid to reduce the degree of acidemia produced by excess H + ions
   e. regulation of acid-base by the kidneys occurs chiefly by increasing or decreasing bicarb ion concentration of body fluids
   f. renal compensation requires more time to begin to make noticeable metabolic compensation adjustments (24 hrs)

Fluid and electrolyte imbalances can be caused by numerous situations/conditions. Anything that causes an output in excess of intake or intake in excess of output can cause a F & E imbalance.

I. Fluid Deficit/Hypovolemia:
   A. inability to ingest appropriate fluids due to difficulty swallowing, weakness, confusion, coma, etc.
   B. excess loss of fluids due to prolonged vomiting, diarrhea, copious drainage from wounds, burns/fistulas; perforate ulcers, intestinal obstruction, blood loss, taking diuretics, irrigation and suctioning of gastrointestinal contents may contribute to a fluid deficit

II. Fluid Excess/Hypervolemia:
   A. may be caused by administering IV fluid at a rate greater than what the kidneys can handle
   B. high fluid intake, high salt or sodium bicarb intake
   C. high risk for impaired kidney function and kidney disease
   D. infants and elderly
   E. congestive heart failure, cirrhosis of liver
   F. taking large doses of steroids

III. Assessment of Fluid Status/Imbalance
   A. To identify patients at risk for fluid imbalance ask the following general questions
      1. Does the patient have any disease or injury that can disrupt body fluid balance?
      2. What kind of imbalance usually follows this condition?
      3. Medications or treatments that affect fluid balance (i.e. steroids/diuretics)?
   B. Know the disease or trauma states that have the greatest potential for altering fluid balance:
      1. kidney diseases
      2. ulcerative colitis
      3. diabetes mellitus/insipidus
      4. burns
      5. hormonal imbalances (ADH/aldosterone)
   C. Watch for dehydration in the elderly; signs of fluid overload in patients with CHF, acute renal insufficiency, cerebral lesions that cause ADH secretion and adrenal insufficiency
   D. Loss of gastric juice often leads to sodium, potassium, magnesium, and chloride deficit and metabolic alkalosis
   E. Excessive perspiration leads to water and sodium deficit; large losses from open wounds lead to deficit of water, sodium, calcium, and protein metabolism
   F. Nursing assessment and observations for fluid and electrolyte deficit/excess imbalances include: temperature, pulse, respiration, blood pressure, skin and membrane changes, speech changes, fatigue threshold, behavior, skeletal muscle functions, anorexia, thirst, and sensory changes. Confirm suspected imbalances with lab data: specific gravity of urine, osmolality, urine I & O volume, daily body weights, and blood gases. Some areas of assessment:

FLUID DEFICIT/HYPOVOLEMIA		FLUID EXCESS/HYPERVOLEMIA	
SIGNS & SYMPTOMS		SIGNS & SYMPTOMS	
Subjective: Thirst, dizziness, feeling faint upon standing, disorientation, recent history of weight loss, headache.	Objective: Less than 20 cc urine/hr. Urine dark and concentrated, dry cracked lips and tongue, thick mucus, dry, scaly skin, poor skin turgor, increase specific gravity, hard, dry stools, fatigue, rapid pulse and respirations, flat neck veins or collapse of veins with inspiration. Increased temperature.	Subjective: History of rapid weight gain, weakness dyspnea, shortness of breath, rales, air hunger.	Objective: Increased blood pressure, fuller pulse, neck vein distention, rapid weight gain, edema, and if severe, pulmonary edema.

Pitting edema is evaluated by using a finger to indent the skin against a bony surface. A four-point scale is used to evaluate the severity of pitting edema: from + 1 (barely detectable pit) to +4 (deep persistent pit approximately 1 inch or 25.4 mm deep). An adult may accumulate up to 10 lbs of fluid before pitting may occur. Edema may become so severe that pitting is not possible; tissue becomes so full that fluid can't be displaced. The skin feels hard or gelatinous to the touch and may look like pig's skin. This is called brawny edema; fluid may ooze from pores.

G. Nursing Interventions:
   1. Deficit
      a. Observe urine for odor, color, clarity
      b. I & O
      c. Assess postural hypotension
      d. Monitor IVs
      e. Monitor daily weights (or at least weekly)
      f. Assess skin turgor and document every 8 hours
      g. Assess oral mucous membranes
      h. Lubricate lips tid/give mouth care prn.
      i. Assess for constipation
      j. Use saline for any irrigations.
      k. Record dressing changes – amount of drainage
      l. Give meds for vomiting and diarrhea
      m. Monitor diet therapy-increase fluids
      n. Assess for anxiety, confusion, agitation
      o. Assess electrolytes, BUN, Creatinine
   2. Excess
      a. Give good mouth care
      b. Give good skin care to prevent skin breakdown due to edema
      c. Make sure linens are dry and smooth
      d. Turn frequently but gently
      e. Monitor fluid restrictions
      f. Monitor low sodium diet
      g. Teach use of high potassium or low sodium diet
      h. Give diuretics (if ordered)
      i. Take daily or frequent weights
      j. I & O
      k. Assess for edema-report and record
      l. Assess for signs of electrolyte imbalances
      m. Assess lung sounds

IV Electrolyte Imbalances
   A. Hyponatremia – Decreased Na +
      1. Causes: high water intake, expansion of total body H_20 (CHF, renal failure); extra renal salt loss (burns, diarrhea, diuretics); cirrhosis/nephrosis
      2. Signs/Symptoms: weakness, apathy, irritability, headaches, wt. loss or edema & wt. gain, hypotension, decr. skin turgor
   B. Hypernatremia – Increased Na +
      1. Causes: profuse sweating, diarrhea, diabetes mellitus/insipidus, hi-protein tube feedings
      2. Signs/Symptoms: intense thirst, dry, sticky mucus membranes, flushed skin, oliguria, possible nausea/vomiting
   C. Hypokalemia – Decreased K +

1. Causes: renal disease/CHF, potent diuretics, drainage/suction of gastric contents prolonged vomiting/diarrhea
2. Signs/Symptoms: muscle weakness, irritability, oliguria, diminished deep tendon reflexes, bradycardia, dysrhythmia progressing to ventricular filbrillation or cardiac arrest

D. Hyperkalemia – increased K +
1. Causes: burns, crushing injuries, kidney disease, excessive potassium infusion
2. Signs/Sympotms: muscle weakness, & fatigue, cardiac dysrhythmias, hypotension,

E. Hypocalcemia – decreased Ca ++
1. Causes: diarrhea, excessive infusion of citrated blood, peritonitis, hypoparathyroidism
2. Signs/Symptoms: tingling in fingertips, numbness in extremities, abdominal cramps, tetany, convulsions, carpopedal spasm, some EKG changes

F. Hypercalcemia – increased CA++
1. Causes: prolonged bedrest, hyperparathyroidism, excessive Vitamin D intake, excessive milk/"hard" water intake, bone cancer
2. Signs/Symptoms: flank pain, kidney stones, nausea/vomiting, anorexia, constipation, stupor and coma, deep bone pain, increased excretion of CA + in urine, EKG changes, excess and deficits of chloride; phosphates, and magnesium exist but are must less commonly noted

I. Intravenous fluid therapy is instituted for a variety of reasons:
   A. Shock, hemorrhage, burns, excessive vomiting/diarrhea, NG suctioning, NPO order, altered level of consciousness.
   B. Other reasons for IV therapy, including:
      1. Provision of a route for IV medications,
      2. Avenue to obtain frequent blood specimens
      3. Provision of a route for physiological monitoring or artificial cardiac pacing
      4. Surgery or emergency situations (lifeline)
   C. Caloric content of IV solutions is low (5% dextrose = .2 cal per cc or 200 cal/1000 cc) so they are rarely administered to meet nutritional needs. Infusions that are administered for nutritional purposes are referred to as total parenteral nutrition (TPN) (Hyperal). TPN solutions will not be addressed as information pertinent to their administration are out of the scope of practice for LPNs in the state of South Dakota.

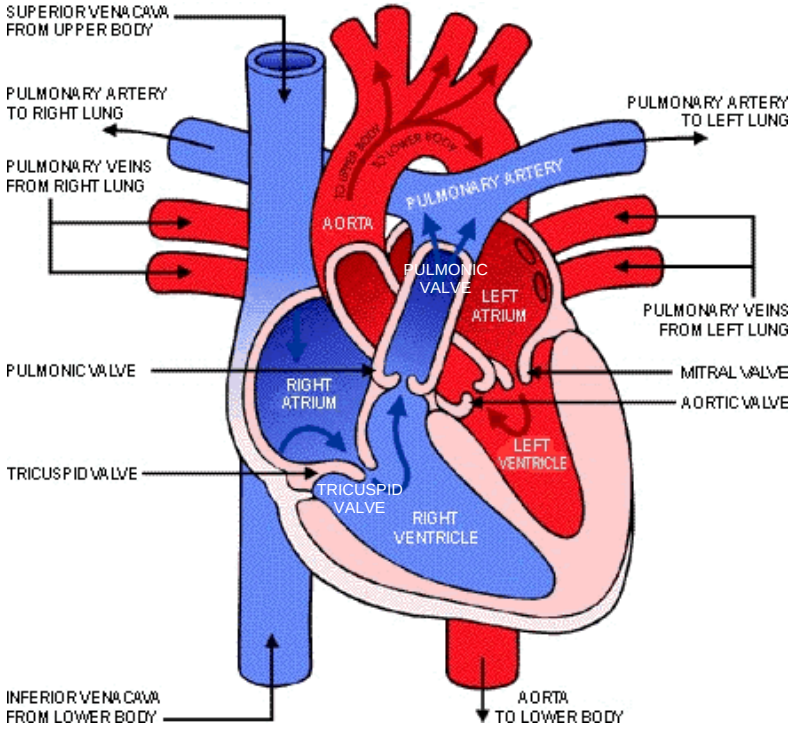
II. A review of some commonly used IV fluids along with their (concentration) and purpose:
   A. Isotonic:
      1. Solution expands extracellular fluid volume
      2. Lactated Ringers (275 mOsm), Normal Saline (308 mOsm), D5W (260 mOsm)
      3. avoid Ringers if pH is above 7.5 or liver disease is present
      4. avoid D5W in increased intracranial pressure because it acts like a hypotonic solution in the body
      5. watch client for signs of fluid overload
   B. Hypotonic
      1. Solution greatly expands intracellular fluid volume, can do so suddenly
      2. 45% Saline (154 mOsm), .33% Saline (103 mOsm), 2.5% dextrose (126 mOsm);
      3. watch client for cardiovascular collapse or increased intracranial pressure as a result of fluid shift;
      4. contraindicated in incr. ICP clients or those at risk for third spacing (i.e. burns, low protein conditions)
   C. Hypertonic
      1. solutions expand ECF volume by pulling fluid from the ICF
      2. D5W in .45 Saline (406 mOsm), D5W in N.S. (560 mOsm), D5W in Lactated Ringers (575 mOsm)
      3. Contraindicated in conditions which cause cellular dehydration (i.e. diabetic ketoacidosis) or those with impaired kidney or heart function
      4. Watch client for circulatory overload

Note: Check with pharmacy if in doubt about interchangeability of solutions made by different companies.

UNIT IV: ANATOMY AND PHYSIOLOGY REVIEW RELATIVE TO INTRAVENOUS FLUID THERAPY

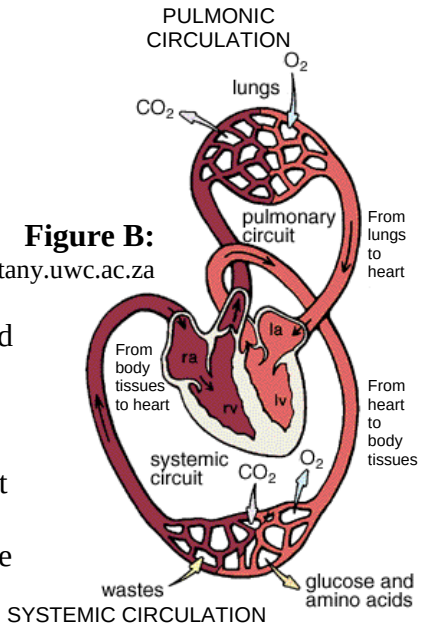
I. Cardiopulmonary System
   A. Anatomy
      1. Blood enters right atrium via the vena cavae, through the tricuspid valve into the right ventricle
      2. Right ventricle pumps blood into pulmonary arteries to the lungs
      3. Oxygenated blood from lungs returns to left atrium via pulmonary veins
      4. Blood flows from left atrium into left ventricle through the mitral valve
      5. Left ventricle pumps blood into aorta which empties into smaller arteries in the systemic circulation
   B. Physiology of the cardiopulmonary system
      1. Heart-acts as pumping device to move blood throughout body
      2. Lungs-site where oxygen is combined with hemoglobin to then be carried to cells, help remove waste products such as carbon dioxide.
   C. Pathophysiological conditions of cardiopulmonary system.
      1. CHF/COPD can interfere with circulation of both IVFT and medications

Figure A: Courtesy www.infomat.net



II. Venous System
   A. Anatomy and Circulation
      1. Venous system is composed of superficial veins and deep veins
      2. Blood moves from capillaries in microvenous circulation to general venous circulation, to the inferior and superior vena cavae, and then into right atrium (figure B)
      3. Blood is moved from periphery by movement of the muscles.

Figure B:
Courtesy www.botany.uwc.ac.za



B. Physiology of the Arterial/Venous System
   1. Nutrients and oxygen pass through arterio-capillary walls by diffusion
   2. Waste products pass through venous capillary walls by diffusion
   3. The exchange is controlled by the autonomic nervous system

C. Pathophysiology of Conditions of the Venous System
   1. Phlebitis-inflammation of the vein wall (which may be caused by injury to the vein and stasis of blood in vein)
   2. Thrombophlebitis-condition in which a clot is formed within the vein lumen (thrombophlebitis may occur in conjunction with phlebitis)
   3. Varicositis-permanently dilated and tortuous veins (occur mainly in leg veins)

      CAUTION: A varicose vein must never be used for IV therapy because the blood is such a vein is relatively stagnant. If a medication is injected into a varicosity, the onset of the action is delayed and a collection of the drug may occur. If for any reason the circulation in this vein is speeded up, an accidental overdose could occur.

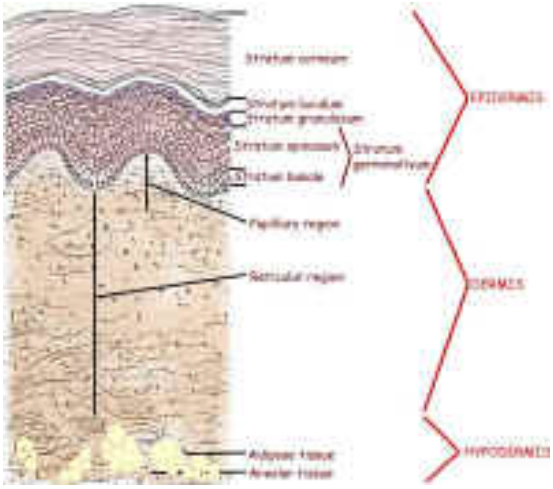
D. Parts of a Vein
   1. Walls
      a. are composed of relatively thin layers
      b. are not as strong or stiff as those of arteries; thus they ten to collapse easily (therefore spasms can occur more readily)
   2. Valves
      a. consist of folds of the inner layer
      b. are found in larger veins
      c. occur where veins branch, often causing a very noticeable bulge
      d. help keep blood from pooling and/or backing up-veins allow blood to move in one direction only

III. Skin Layers

A. Epidermis – Outermost layer
   1. protective layer
   2. thickness varies

B. Dermis – Innermost layer
   1. sensitive and highly vascular
   2. contains many capillaries
   3. contains thousands of nerve fibers (the number of nerve fibers varies in different areas of the body. Pain felt varies according to the number of nerve fibers and the protective thickness of epidermis)

Figure C: Courtesy www.lionden.com



UNIT V: EQUIPMENT AND SUPPLIES USED IN INTRAVENOUS THERAPY

I. Types of IV Solution Containers
   A. IV Bags
      1. Filled under sterile conditions in factory and occasionally re-mixed in pharmacy
      2. Composed of strong puncture resistant polyvinylchloride (PVC) plastic
      3. Come in a variety of sizes including partially filled bags containing 50-1000 ml.
      4. Advantages
         a. Collapse slowly as fluid is being infused into patient, therefore no air venting is required; a truly closed system, minimizing the risk of airborne contamination
         b. Can fairly easily be 'threaded' through patient's gown while still attached to patient unless infusion pump is being used
      5. Disadvantages
         a. Flexibility can make more cumbersome to manipulate and possibly more subject to touch contamination, unless aseptic practices are rigidly observed
         b. Outer wrap of polyethylene is required to prevent the gradual loss of fluid due to moisture while the container is being stored
         c. Plastic containers not completely inert, and thus some components (plasticizers) can be drawn or leached from the bag into the solution; and likewise, certain substances from the solution can be absorbed onto the interior surface of the container
         d. Some studies do differ as to whether glass bottles or plastic bags tend to contain more particulate matter
   B. IV Bottles
      1. Sizes range from 150 to 1000 ml; partially filled bottles contain 50-750 ml
      2. All glass bottles currently used are vacuum bottle designed with a rubber-stopper closure, through which the piercing pin of the administration set is inserted; however bottles with rubber stoppers do not provide a completely closed system since air venting is necessary
      3. Bottles must be vented in one of two ways: (1) directly by means of an air tube within the bottle which goes through the rubber stopper and opens into the air (since the air entering is not filtered, contamination is possible though unlikely); (2) no direct air vent, uses an air inlet on the administration set, located between the drip chamber and piercing pin, it is covered with a bacterial retentive filter to reduce the chance of contamination
      4. Advantages
         a. Bottles' rigid construction makes them easier to manipulate when adding medications and attaching administration tubing, and allow fluid levels to be measured with greater accuracy
         b. Being biologically inert, they do not generate particulate matter and are compatible with virtually all fluids and medications
      5. Disadvantages
         a. Bottles tend to break more easily
         b. Bottles are heavy to handle
         c. Bottles require a greater amount of storage space than plastic bags – disposal can also require more space
   C. Inspection of Container for Defects
      1. Verify the type and volume of solution.
      2. Check the expiration date; discard solution if the expiration date has passed, even if there are no visible signs of contamination or deterioration.
      3. With glass bottles, check all surfaces for chips or cracks: hold the bottle up to a light and observe for sudden flashes of light which can indicate a microscopic crack; true defects must be distinguished from seams on the side or bottom of the bottle.

4. With flexible plastic containers, gently squeeze the bag to detect any leaks.
5. Observe for clarity of the solution. Should any discoloration, cloudiness, or particulate mater be noted, discard the solution and report it to the pharmacy or responsible department so that other containers in the same lot can be checked.

II. Types of IV Tubing Drip Systems

A. Micro drip
1. Has a distinctive metal tip where drop is formed
2. May also be called minidrip or pediatric infusion set
3. Forms very small drop, 60 gtts per ml
4. Simplifies counting out and setting flow rate i.e. if order is for 85 ml per hour, nurse can count 85 gtts/per/min
5. Can deliver very small amounts due to small size of drop and less time elapsing between drops; over a long period of time flow rates as low as 5c per hour can be maintained
6. Helps prevent accidental overload (which is less likely to happen due to size of drop)

B. Macrodrip
1. Is called infusion set
2. Deliver different drip rates due to different size drops – determined by manufacturer: Travenol = 10 gtts/ml; Abbott, Cutter, McGaw = 15 gtts/ml; IVAC = 20 gtts/ml
3. Requires use of formula to calculate rate of drops per min and flow rate
4. Can deliver very large volumes in a very short time i.e. 1000 ml. in 15-30 min. (vol. & time will depend upon size of needle/catheter in the vein)

C. IV Tubing Containing Multiple Secondary Ports
1. Consists of straight tubing with more than one secondary port (called y-injection sites)
2. Can have either type drip system
3. Can be used when administering multiple IV piggyback medications
4. Allows main IV solution and piggyback solution to run simultaneously
5. Is useful when both IV piggyback and IV push medications are ordered

D. IV Tubing Containing Backcheck Valves
1. Contains multiple secondary ports
2. Allows only one solution at a time to flow (valve in tubing just opposite or slightly below uppermost secondary port prevents flow of more than one solution at a time)
3. Requires a short secondary IV tubing for infusion of medications

CAUTION: Whenever a tubing is inserted into another tubing with a needle, this connection must be taped. The secondary tubing should be left in place and changed only when the primary tubing is changed.

4. Can be used when administering multiple IV piggyback medications

E. Vented and Nonvented IV Tubings
1. Vented
   a. Straight IV tubing with either type of drip system
   b. Multiple secondary ports and/or backcheck valve
   c. Filtered openings to allow air to enter system
   d. Must be used with non-vented glass bottles (vent allows fluid to run from bottle and air to go in bottle)
   e. May also be used with any container
2. Non-Vented
   a. Straight IV tubing with either type of drip system
   b. Multiple secondary ports and/or backcheck valves
   c. Closed system with no opening.
   d. May be used with vented glass bottle, plastic bag or plastic bottle

F. Types of Clamps and Their Uses
   1. Roller: used to regulate flow rate; thumb used to move roller up to open, down to close line
   2. Screw: used to regulate flow rate; turn clockwise to open line, counterclockwise to close line
   3. Slide: used to turn IV on or off; tubing is slid into wide opening to turn IV off – slide clamp should not be used to regulate flow rate

E. Characteristics of Terminal Filtering Devices
   1. Consists of transparent filter housing and membrane filter
   2. Come in many different sizes and types
   3. Used to remove particulate matter and contaminants such as bacteria and to eliminate air above filter
   4. Have slide clamp to temporarily turn off flow of solution
   5. May be built into IV tubing or as separate unit to be added
   6. May contain secondary ports (which permit infusion of fluids such as blood, suspensions and colloidal solutions below the filter; these fluids would otherwise occlude the filter)
   7. Have range of porosites from 0.22 microns to 3.5 microns-this range is useful for removing different size particles and bacteria
   8. Points to consider when using a filtering device
      (NOTE: some facilities require the use of filters on all IVs)
      a. Risk of phlebitis is reduced – NOTE: if multiple irritating solutions or medications are to be given, research has shown that use of a filter reduces incidence of phlebitis
      b. Correct-sized pore must be chosen to allow prescribed solution to infuse
      c. Discoloration by particulate matter is sometimes seen in filter - NOTE: the filter can continue to be used as long as the solution continues to infuse at the proper rate, this discoloration means that the filter is working properly by filtering out particles
      d. Highly viscous fluids must be piggybacked below the filter
      e. Medication must be properly dissolved before infusing
      f. Filter must be changed every 24 hours - NOTE: when filter removes large amounts of undissolved crystals it may clog and will need to be changed more frequently
      g. Filter is usually placed in the line below the pump when used with an infusion pump. NOTE: placement of a filter above or below an infusion pump depends upon the type of pump and solution used; check manufacturer's specifications for use with a filter

III. Characteristics of Basic IV Needles/Catheters

A. Types of Basic IV Needles/Catheters
   1. Wing-tipped needle/butterfly
      a. Short steel needle connected to flat piece of plastic (wings); short piece of plastic tubing with a plastic female adapter
   2. Over-the-needle catheter (ONC)
      a. ½ inch to 3 inch plastic catheter attached to a rigid hub
      b. Needle or stylet fits inside plastic catheter to facilitate entry through skin and into vein
   3. Heparin Lock
      a. Can be either a wing-tipped needle or an over-the-needle catheter
      b. Has an intermittent injection cap inserted in female adapter – NOTE: the plastic injection cap can be fused into the tubing and be a permanent part of the device, or a separate injection cap can be attached
   4. Needleless System
      a. New devices being used with increasing frequency in different practice settings
      b. Consists of original needle which actually enters patient's skin
      c. Has potential to replace up to 80% of hospital needles and so significantly reduce potential needle sticks sustained by health care personnel

B. Uses for IV Needles and Catheters
    1. Wing-tipped needle
        a. Infants and children
        b. Elderly patients/adults with small and/or tortured veins
        c. Short term IV therapy – less than 24 hours
        d. As a heparin lock
    2. Over-the-needle catheter
        a. Long-term therapy – over 24 hours
        b. Delivery of viscous liquids (i.e. peripheral hyperalimentation solution, blood and blood products)
        c. Arterial monitoring
        d. As a heparin lock
    3. Heparin Lock
        a. To give IV medication intermittently without using continuously running IV fluids
C. Advantages and disadvantages of basic IV needles and catheters
    1. Wing-tipped needles
        a. Advantages
            1. simple/easy to use
            2. less painful upon insertion
            3. reduces touch contamination
            4. less likely to trigger mechanical phlebitis
        b. Disadvantages
            1. less stable
            2. unsuitable for infusing highly viscous liquids
            3. unsuitable for long-term therapy
            4. can puncture vein/infiltrate more easily because of inflexible needle point
    2. Over-the needle catheter
        a. Advantages
            1. Less likely to puncture vein/infiltrate because of flexible plastic. CAUTION: This advantage tends to make it possible for the catheter to be left in one site for long periods of time. The IV site must be changed every 48 to 72 hours to prevent occurrence of other complications.
            2. Allows needle (stylet) to be completely removed after insertion
            3. Allows patient greater mobility because of its stability
            4. Some indication that thin-walled catheters are preferable to thick-walled for ease of insertion
            5. Different brands of ONC seem to affect degree of painfulness upon insertion
        b. Disadvantages
            1. more likely to damage vein during insertion
            2. prone to touch contamination
            3. can support infection
            4. likely to trigger a mechanical phlebitis-incidence of mechanical phlebitis increases with length of time catheter is left at a given site
    3. Heparin lock
        a. Advantages
            1. allows greater patient mobility
            2. is more comfortable
            3. prevents risk of accidental fluid overload
            4. reduces risk of complications of long term IV therapy (i.e. infiltration, phlebitis)

b. Disadvantages
    1. wing-tip can damage vein on insertion
    2. ONC prone to touch contamination-mechanical phlebitis
    3. must be flushed with heparin/saline at intervals
    4. must be flushed before and after administering medication-heparin/saline flush is used to prevent clotting of blood in the needle or catheter

IV. Infusion Pumps

A. Reasons to use infusion pumps
1. Gravity flow infusions are frequently not trouble free and there remain many instances in which absolute accuracy must be insured in the administration of drugs and fluids
2. In addition to the potentially serious problems that can result from infusion of drugs and fluids at an inaccurate rate, manually controlled flow presents other disadvantages
3. Greater expense can be incurred in the long run due to added volumes of fluid required either as a vehicle for the medications or to maintain patency of the vein
4. Clotted cannula due either to a flow that has stopped or a container that has run dry can result in frequent restarting of the infusion and added discomfort to the patient
5. Many or all of these problems can be eliminated by use of infusion controllers and pumps
6. All types of pumps regardless of construction and delivery features operate under a similar principle – that of infusing fluid into a vein under pressure
7. Most pumps are equipped with at least four types of alarms:
    a. low battery
    b. infusion complete
    c. air in line
    d. occlusion

B. Types of Infusion Devices
1. Controllers
    a. electronic device used to regulate IV flow rates
    b. rely on gravity rather than exerting pressure
    c. rate regulated either by electronically monitoring the drop rate or by regulating the passage of fluid through the tubing by means of a magnetically activated metal ball valve which synchronizes with a drop detector
    d. controllers are limited by the fact that drop rate is not a completely accurate reflection of volume infused due to variations in drop size; despite such variations, controllers can be of value with a wide range of fluids and medications
    e. since the design of controllers is mechanically simpler than that of pumps, they can be assembled easily and rapidly and should require less frequent maintenance
    f. controllers more economical to operate therefore more appropriate for a large percentage of infusions which do not require the accuracy of pumps
2. Infusion Pumps
    a. in contrast to controllers, pumps operate by exerting pressure either on the IV tubing or on the fluid itself
    b. since they pump against pressure gradients, a constant infusion rare and volume can be maintained even with fluctuations in the patient's venous pressure
    c. in addition, pumps can infuse large volumes of fluid through a micropore filter
    d. to produce the pumping action, one of two basic mechanisms is utilized; either a peristaltic action or piston cylinder action
    e. specialized types of infusion pumps are as follows:
        1) syringe pumps (small volumes i.e. peds, critical care)
        2) volumetric pumps (more sophisticated version of above)
        3) miniature infusion devices (slow rate/ extended time period)
        4) implantable infusion pumps (i.e. insulin/terbutaline pumps)

I. Procedure for Starting an Intravenous Infusion
   A. Review physician's orders
   B. Wash your hands
   C. Choose appropriate equipment
      1. IV pole
      2. Solution
      3. Administration set
      4. IV pole
      5. Tourniquet
      6. Antiseptic
      7. Means of IV access i.e. abbocath
      8. Tape
      9. Dressing materials
      10. Armboard (if necessary)
      11. Gloves
   D. Set up IV fluid and tubing
   E. Take equipment to bedside
   F. Identify patient
   G. Prepare patient psychologically
   H. Adjust lighting
   I. Prepare patient physically
   J. Wash your hands and put on gloves
   K. Select position of comfort for yourself
   L. Locate vein. Apply tourniquet
      1. For the adult patient, IV infusions are usually started in a hand. Legs are avoided because of the danger of thrombus formation and subsequent pulmonary emboli.
      2. Selection depends on a number of factors, including the reason for the IV, the length of time it is expected to be needed, the condition of the patients veins, and the patient's comfort and safety.
   M. Release tourniquet
   N. Clean area thoroughly
   O. If policy is to anesthetize area, do so now
   P. Reapply the tourniquet
   Q. If using a device with a catheter, inspect for defects
   R. Insert needle and advance cannula
   S. Release tourniquet
   T. Connect tubing and initiate flow
   U. Remove gloves, tape cannula, dress site
   V. Adjust flow rate
   W. Care for equipment
   X. Wash hands
   Y. Evaluate using the following criteria:
      1. Right patient, right solution, right time, right amount, right rate, correctly documented.
      2. IV secure
      3. Patient comfortable
   Z. Document IV insertion on appropriate chart forms

I. A central intravenous catheter is a long catheter that is inserted into a vein in the shoulder or neck area. The tip of the catheter is in the superior vena cava or right atrium of the heart. This type of catheter is used for long-term IV therapy.
   A. Types of central venous catheters
      1. PICC (peripherally inserted central catheter)
      2. Hickman single and double lumen catheters
      3. Port-a-cath *NOTE accessing this type of catheter is beyond the scope of practice for the LPN in South Dakota
      4. Internal jugular catheters, single, double or triple lumen NOTE: The multi-lumen catheters have separate color-coded ports, each going to a different lumen. Each lumen exits separately from the lumens. It is therefore possible to designate each for a separate purpose. For example, the triple-lumen catheter can have one lumen designated for nutritional solutions, another for drawing blood, and the third for intermittent medications. Any one, two or all three may be capped and filled with heparinized saline or saline solution for intermittent use.

Figure D: Courtesy connection.lww.com

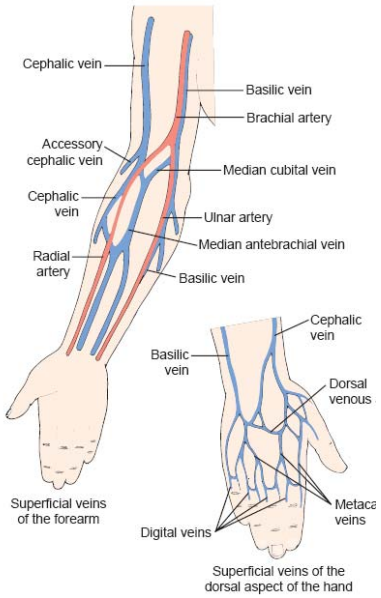
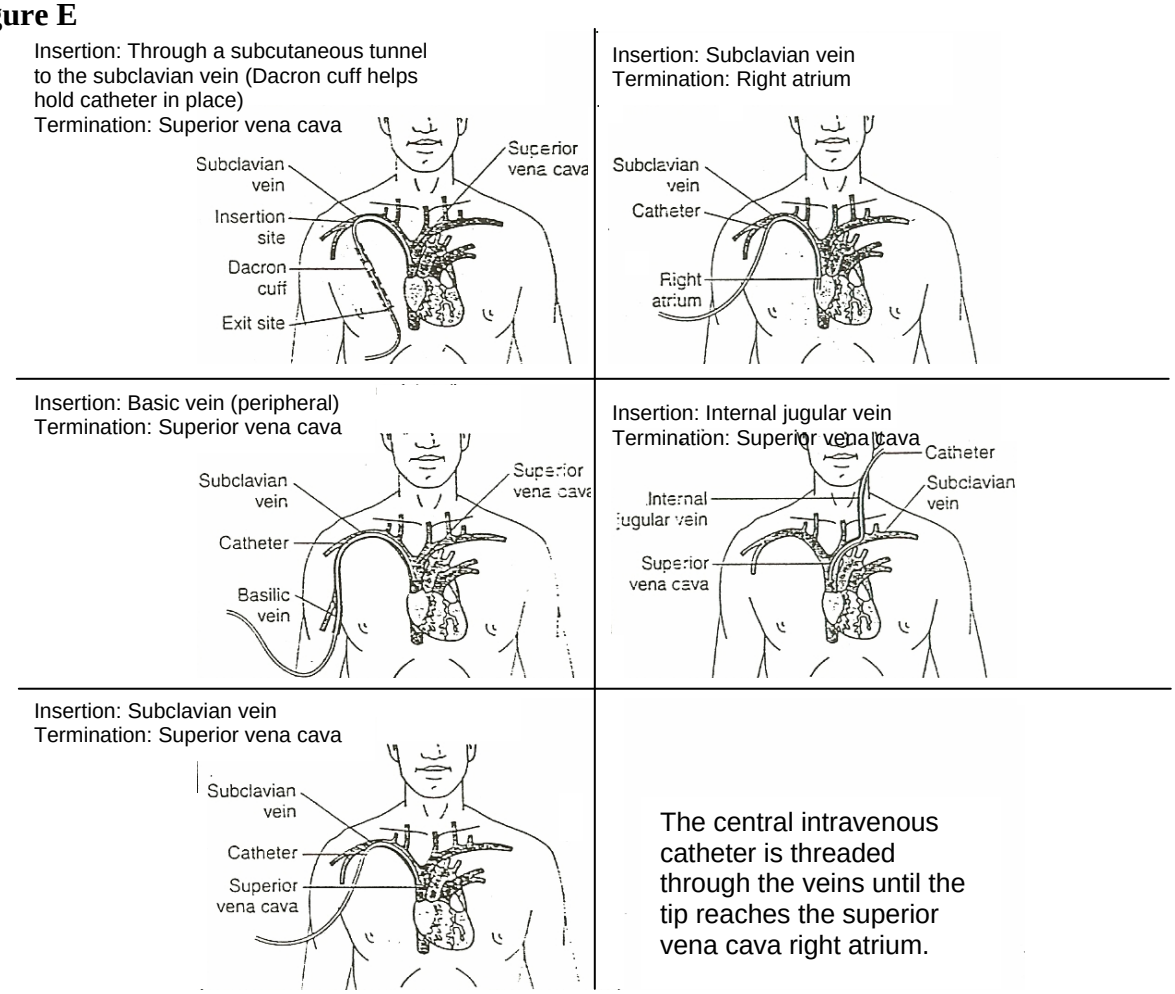


Figure E



II. Central line dressing changes

A. Changing the dressing is a sterile procedure. Strict aseptic technique must be maintained. Like the peripheral catheter, the type of dressing and the frequency of dressing change are determined by facility policy.

B. Central line dressing change procedure

1. Supplies needed:
    a. Central IV dressing kit or individual supplies
    b. Disposable exam gloves
    c. Sterile gloves, size to fit
    d. 3 masks
    e. Transparent film dressing or other sterile dressing
    f. Tape, if needed to secure dressing
    g. Sterile drape
    h. 3 providone-iodine applicator sticks
    i. Plastic bag for used supplies
2. Cleanse the table that will be used to establish the sterile field with alcohol or other disinfectant. Allow to dry.
3. Apply a mask. Instruct the patient to apply a mask, or turn the patient's head to the side opposite the insertion site, according to facility policy.
4. Wash your hands.
5. Using the sterile drape, set up the sterile field. Open packages of sterile supplies, placing them on the sterile field. Avoid turning your back on the sterile field.
6. Apply disposable exam gloves and remove the soiled dressing. Discard in the plastic bag. Keep the soiled dressing and the plastic bag well away from the sterile field. Avoid reaching over the field to discard the dressing.
7. Remove gloves and discard in the plastic bag.
8. Wash your hands.
9. Cleanse the skin with the providone-iodine applicators, three applicators are needed to cleanse the skin for this procedure. Discard used applicators in plastic bag.
10. After skin dries, use gauze or transparent dressing to cover the insertion site. Secure with tape if a gauze dressing is used.
11. Remove your gloves and mask. Assist the patient to remove mask, if necessary.
12. Remove used supplies and discard according to facility policy.

III Central line flushes

Please consult facility policy or physicians order regarding frequency and dosage requirements for flushing various types of central lines.

NOTE: Insertion or removal of central or midline catheters is beyond the scope of practice for the LPN in South Dakota.

I. Guideline for maintaining prescribed flow rate: the health care provider prescribes a flow rate depending on the individual patient's needs; it is the nurse's responsibility to monitor and maintain that flow rate
   A. Using a timing strip – use a timing strip even when using an infusion pump; these strips provide a quick method for checking whether or not the correct amount has infused in the correct time period; for greater accuracy, mark the strip in hourly increments
      CAUTION: When using a manufacturer's timing strip, be sure that it is on the appropriate container: an Abbott strip cannot be used with a Cutter bottle, and a Travenol glass bottle strip cannot be used with a Travenol plastic bag.
   B. Calculate flow rate in drops per minute, and then count out the drops per minute when using the gravity flow and clamp system; monitor drops per minute as well as total amount infused each time the container is checked. IV DRIP RATE CALCULATION FORMULA:

$$\frac{\text{ml per hr x drop factor}}{\text{time in minutes}}$$

   C. Check IV container and tubing for flow rate at least hourly; know your institution's policy.
   D. Maintain appropriate distance between container and insertion site; the container should be kept 2 ½ to 3 feet above the insertion site or high enough to allow appropriate fluid flow.
   E. Provide enough tubing to allow the patient free movement (i.e. extension tubings)
      NOTE: calculating the correct length of tubing is very important; if tubing is too short, the patient could accidentally pull the needle or catheter out of the vein; if tubing is too long, the patient could turn over on it and pinch it off.
   F. Enlist patient's help and cooperation

II. Factors that Influence Flow Rate
   A. Position of container in relation to insertion site
      1. Increasing the distance between the container and the site increases the flow rate i.e. increasing the distance from 3 feet to 6 feet increases the flow rate by 400%.
      2. Decreasing the distance between the container and the site decreases the flow rate i.e. decreasing the distance from 4 feet to 3 ½ feet decreases the flow rate by 77%.
   B. Viscosity of fluid
      1. increase causes resistance to flow
      2. increase requires an increase in pressure to move fluid through tubing i.e. hyperalimentation solutions and blood/blood products are viscous fluids that resist flow and require increased pressure
   C. Gauge of needle and/or catheter and use of filter

III. Instructions about IV Therapy to be Given to Patient
   A. Instruct patient to:
      1. use other arm for tasks; this instruction will vary with the type of needle or catheter used and the site of insertion
      2. keep arm below level of heart. NOTE: unless an infusion pump is used, an arm raised for an extended period will change the flow rate; however, raising the arm occasionally will not necessarily interfere with the IV
      3. not disturb tape or dressing
      4. notify nurse if problems occur with equipment or insertion site. EXAMPLES: Call if:
         a. blood is noticed in tubing, on dressing, or on bed
         b. IV stops running or begins to run very rapidly
         c. Burning or itching is noticed at insertion site
         d. Any wetness is noticed on dressing or bed
         e. Any connections or needles come loose

5. not to tamper with any of the equipment i.e. control clamp, IV pole, infusion pump (if patient will not leave clamp alone, place a piece of tape just under the clamp to keep it under the drip chamber and out of the patient's reach)
6. how to move a mobile IV pole if allowed out of bed; put robe on, etc.

B. Nursing Considerations
1. Keep bedside table/chairs on side of bed opposite insertion side
2. IV pole on insertion side of the bed
3. patient's robe/slippers close/on insertion side of the bed
4. Tape all connections-taping connections prevents accidental separation if the patient places any tension on the IV system. If there is going to be any extra strain on the tubing, tape the tubing on the IV pole.

IV. Administering Basic IV Solutions

When monitoring an IV infusion, the LPN will assess how much fluid is left in the IV container, identify when there is the problem of not enough solution left for continuous infusion and will hang a new IV solution container so that the goal of maintaining a continuous intravenous infusion free from complications is met.

A. Procedure for replacing an empty IV basic solution bag or bottle with a full IV basic solution bag or bottle:
1. Assess how much fluid is left in the hanging IV solution container. Change when a small amount of fluid still remains in the neck of the container. NOTE: the amount left in the old solution container needs to be documented on the appropriate I and O sheet.
2. Check the physician's order/nursing care plan to verify type of fluid solution and rate of infusions.
3. Obtain new IV container. Verify that it is:
   a. the correct solution.
   b. for the correct patient.
4. Inspect solution container according to criteria outlined elsewhere in this module
5. Calculate rate of infusion and mark container appropriately (outlined in this module)
6. Wash hands
7. Identify patient. Explain procedure and reassure as needed.
8. Spike container
   a. IV Bottle
      1. spike container (rubber disk) maintaining sterility
      2. fill tubing drip chamber and tubing to remove air
      3. vented bottles should produce hissing sound when spiked
   b. IV Bag
      1. spike container by removing sterile plug & puncturing membrane of IV bag
      2. fill tubing drip chamber and tubing to remove air
9. Adjust flow rate to prescribed amount via clamp or IV pump
10. Document change of solution container on appropriate sheet/chart. State time, type and amount of solution hung and flow rate
11. Maintain solution per institution policy
    a. Change IV solution every 24 hours – a 24 hour solution change usually applies only to low flow rate IVs; if IV flow rate is fast solution will need to be changed more frequently due to IV bag/bottle running out
    b. Change IV tubing every 24/48/72 hours depending upon institution policy and whether additives (i.e. KCL) have been added to the original IV solution
    c. Clean, inspect, and redress insertion site every 24 hours; when transparent dressings such as OP-site or Tegaderm are used, they are left in place until the IV is discontinued

d. Change IV insertion site at least every seventy-two hours – the insertion site must be changed more frequently if any signs of phlebitis are noted or if irritating solutions or medications are being infused
e. Re-label solution, tubing, and site every time any part of the system is changed
f. Use strict aseptic technique whenever handling any part of the IV system
g. Discontinue IV as necessary
h. Restart IV as necessary

V. Nursing Interventions with regard to Monitoring the IV System/Patient

While the LPN cannot alter the ordered IV flow rate, the rate must be monitored and observed regularly. The type of solution and medications being infused will affect how often observations need to be made. Even if the IV is on an infusion control device, the drip rate and fluid level in the container should be checked frequently.

A. Patients in the following categories need to have their IV flow rate closely monitored as they are more prone to complications:
   1. Patients receiving antibiotics and very toxic medications i.e. cancer chemotherapy, amphotericin B, etc.
   2. Patients receiving an IV at the rate of 150 cc or greater an hour.
   3. Debilitated patients (elderly, post-op, burns, vomiting, and diarrhea.)
   4. Infants/children
   5. Patients who have a history of heart, lung, and kidney problems.

B. On these points
   1. Check status of IV thirty minutes after IV line is established
   2. Check status of IV flow rate and volume delivered at least every hour during your shift

C. Complications may result if the rate is too fast or too slow
   1. If the flow rate is too slow, the LPN needs to:
      a. check the tubing for kinks, loose connections, correctly functioning infusion device etc. that could occlude the IV line. Correct the problem if found.
      b. make sure the IV container is high enough for gravity to assist in infusing fluid. NOTE: fluid in a gravity drip infusion will stop in the tubing when reaching heart level.
      c. instruct ambulatory patients to keep IV arm at waist level to keep blood from backing up into tubing.
      d. assess IV site for previously discussed problems
   2. The most common complication that results when the rate is too slow is clot formation in the IV needle and/or tubing. No nurse should irrigate a clotted IV needle/tube; irrigating will push the clot into the blood stream and could cause a pulmonary embolism. Once a clot has formed, the IV will probably need to be restarted.
   3. If the rate is too fast, the LPN needs to:
      a. Check tubing connections and IV site for wetness, leaks, and loose connections, and correct any such conditions. Make sure sterile technique is used and the IV line is not contaminated. If contamination occurs, a complete tubing change may be necessary.
      b. Assess IV site for previously discussed problems.
   4. The most common complications of too fast a flow rate are:
      a. Speed shock: a severe systemic reaction to rapid administration of IV fluids containing drugs. Symptoms include pounding headache, increased blood pressure, possible loss of consciousness, rapid pulse, apprehension, chills, dyspnea, and other symptoms specific to medication in IV solution. The LPN should slow rate, take vital signs, assess neurologic and respiratory functions, and notify healthcare provider.

b. Circulatory overload (hypervolemia), which results in congestive heart failure or pulmonary edema. Signs that would alert you to this include shortness of breath, dyspnea, coughing, rales, dilation of neck veins, and decreased urine output (in relationship to intake). Other signs/symptoms would be sweating, frothy or pinkish sputum, puffy eyelids, ascites, weight gain and pitting edema. This could be a life-threatening situation if not corrected immediately. The LPN should take vital signs, administer oxygen, and position the patient with head up to facilitate breathing, observe for any of the above signs, and notify healthcare provider.

D. Documentation
   1. Monitor the flow rate periodically throughout the shift, including:
      a. type of solution infusing
      b. rate per hour IV is infusing
      c. if on infusion control device
   2. Documentation concerning the IV site
      a. Check status of patient for local and systemic complications
      b. Check patient's psychological tolerance of IV therapy. Check for tolerance of limited mobility, adherence to instructions, and any untoward reactions. This status check should be done 30 minutes after establishment of line and then at least twice a shift.
      c. Monitor for hemodynamic changes – Observe patient for respiratory distress with every status check; auscultate the chest for breath and heart sounds at least twice per shift or if any signs of distress are noted.
      d. Check patency of needle or catheter – This check must be done before administration of medication and whenever there is any doubt about patency.
      e. Check stability of solution – Monitor solution for any physical changes such as crystals, color change, or gas release (bubbles)
      f. Check for air in tubing. Air may enter tubing and cause an air embolus if container empties before the bottle is changed.
   3. Monitor urine output; patients on IV therapy should be on I & O to check the status of their hydration.

I. This type of unit is ideal for patients who require intermittent medications without a need for fluids, eliminating the fluid container/tubing increases patient mobility and comfort and reduces expense.

II. Device is also used on a temporary basis to instill medication for laboratory exams (i.e. nuclear med) and then is discontinued when no longer needed.

III. Frequently, a short piece of adaptive tubing (T connector) may be attached to the hub of the needle to facilitate patient movement and protection of the IV site before attachment of the Heparin lock.

IV. Any already inserted needle/catheter may be converted to a heparin lock by using an adaptor plug which consists of a short male adapter with a resealable injection cap; after it is securely inserted into the cannula hub, the unit is flushed with any of three solutions noted below and used as a standard heparin lock.

V. The patency of these units is maintained with:
   A. a weak heparinized solution
   B. a heparinized/saline solution
   C. a plain saline solution
   D. these solutions are instilled after each dose of medication, or at regular intervals if no medication is being given

VI. Even with these devices, phlebitis can still occur with the risk increasing the longer the catheter or needle remains in the vein
   A. Since the risk of such complications is diminished when the needle is replaced every 48 to 72 hours, it is recommended that this be a routine procedure for all types of IV cannulas. Using the heparin lock for intermittent infusion of medications will be covered in Unit IX.

The LPN will continuously assess the patient for previously described problems and complications that would necessitate discontinuance of the IV. The goal is to discontinue the infusion and remove the intact IV needle without causing any complications.

I. Procedure for discontinuing the intravenous line uses sterile technique and is as follows:
   A. Check the physician's order for discontinuing the IV.
   B. Check chart to see what type and length IV needle was inserted.
   C. Assemble equipment:
      1. sterile 2x2 gauze sponge or cotton ball
      2. antiseptic ointment (if used in agency-check policy)
      3. band-aid (or another 2x2 gauze sponge)
      4. tape (if band-aid not used)
      5. gloves
   D. Identify patient and explain procedure.
   E. Provide adequate lighting.
   F. Wash hands. Put on gloves to protect self from potentially contaminated blood.
   G. Stop the flow of the infusion by turning the clamp completely off.
   H. Some institutions indicate the necessity of applying a tourniquet above the insertion site to prevent part of a catheter/needle from traveling to the heart/lung if it were to break off.
   I. Loosen and remove all tape, the IV dressing and other securing devices (op-site, gauze, arm board, etc.). Stabilize the IV needle when loosening tape.
   J. Place sterile gauze or cotton ball over the needle insertion site, applying slight pressure.
   K. Remove the IV needle/catheter, following the path of insertion. As needle is withdrawn, and when it is completely out, apply more pressure to the insertion site and elevate extremity.
   L. Assess that the needle/catheter is completely intact. If it is not, notify physician immediately.
   M. When bleeding at the site has stopped or decreased, the gauze or cotton ball may be taped in place, or a band-aid applied. Some agencies apply an antiseptic ointment to the site before securing the dressing.
   N. Discard the needle, tubing, and solution container appropriately according to agency policy.
   O. Remove gloves. Wash hands.
   P. Assess site several times during the next 30 minutes for any bleeding.
   Q. Document in the nurses notes and/or IV flow sheet the:
      1. time, site, and type of needle removed
      2. reason for discontinuing IV
      3. condition of catheter/needle (intact)
      4. assessment of the site and other responses of the patient (if appropriate)
      5. amount of solution infused (also need to chart on I & O record)

II. Possible complications from the discontinuance of an intravenous infusion include:
   A. Hemorrhage and/or hematoma (blood in tissue) at the site. Applying pressure with a dry, sterile sponge for 30-45 seconds after needle removal usually prevents excessive bleeding.
   B. Catheter embolism, caused by the breaking off of a part of the catheter or needle. The fragment may travel to the right ventricle of the heart and block blood flow. Needles and catheters should be withdrawn carefully and the length verified upon withdrawal. Application of a tourniquet above the insertion site before catheter withdrawal should stop such a fragment from traveling too far. Usually the fragment must be removed surgically. If the IV catheter/needle is not totally intact, the physician must be notified immediately.

I. Infectious Process
   A. Three factors influence the development of inflammation leading to phlebitis:
      1. chemical = pH of infusing solution, osmolality of solution (incr. by addition of electrolytes and antibiotics, amount of particulate matter
      2. mechanical = size of cannula inserted, location of insertion site, size & condition of vein, technique of clinician inserting cannula
      3. septic = can occur in small number of patients (see description below under septicemia)
   B. The skin (being a primary natural barrier) has been broken and thus integrity compromised leaving an avenue for potential infection.
   C. A few factors influencing the body's response to IV cannulation are the patient's immune system nutritional/hydration status, and coping mechanisms to stressors.
   D. The following is a brief listing of some of the defensive systems in the body that are called into action when a potential inflammatory/infectious process might be beginning:
      1. skin and mucus membranes
      2. spleen
      3. bone marrow
      4. liver
      5. white cells, macrophages, interferons
      6. hormones (i.e. histamine, prostaglandins)
   E. Detailed descriptions of the inflammatory/infectious response will not be included in this continuing education module – the reader is referred to any good medical/surgical textbook or anatomy and physiology text for further exploration of these two complex reactions.

II. Transmission of Microorganisms/Prevalence of IV Therapy Associated Infections

Infection, a common and serious hazard of IVFT, can be introduced at the time of cannula insertion or subsequently through contaminated fluids or equipment. Phlebitis is the most common complication of IV therapy; it can affect 25-70% of hospital patients, about 60% of whom develop clinical indicators of phlebitis between 8-16 hours after insertion.

According to IV Nursing Standards of Practice, the presence of pain alone does not indicate phlebitis, but the presence of pain at the insertion site may be a precursor to phlebitis and require removal of the cannula. When the vein wall is punctured, an injury to the skin as well as trauma to the vessel wall occurs. Patients receiving IV therapy may experience temporary discomfort from venipuncture. Usually this discomfort is quickly resolved, but with some patients trauma and injury to the vessel wall can set the stage for phlebitis.

While simple infusion phlebitis sometimes has an infective component, it is felt to have a physiochemical basis more frequently. Mechanical irritation of the vein is also a primary factor in the development of phlebitis. When localized infection is evidently present, it is often treated conservatively, and only rarely are antibiotics needed.

Two IV-associated infections, septicemia and suppurative thrombophlebitis are very serious.

   A. Septicemia/Sepsis
      1. generalized infection throughout the bloodstream resulting from the introduction of organisms (bacteria or fungi) into the circulation (bacteremia/fungicemia)
      2. for patients on IVFT, organisms can enter the blood stream as the result of contamination of virtually any component of the IVFT system
      3. tends to occur more frequently with clients receiving TPN (total parenteral nutrition) development, of sepsis more fatal to immunosuppressed or severely debilitated patients
      4. variety of organisms have been associated with infusion septicemia
      5. bacteremia can resolve uneventfully after removal of the contaminated fluid or cannula, in some instances, without need for other treatment. However, since septicemia may lead to a severe systemic infection, it can represent a serious hazard for many patients, particularly if the source of infection is not immediately suspected and detected and the IV line is allowed to remain in place

6. after apparent improvement, secondary complications such as endocarditis can occur
7. signs/symptoms include sudden onset of fever, chills, hypotension cold sweat; occasionally there may be nonspecific GI symptoms (nausea, vomiting and diarrhea) and neurological symptoms and shock
8. a number of patients with infusion-related septicemia do not show local signs of phlebitis so other sources of infection such as UTI or pneumonia may initially be suspected; if treated with antibiotics without removal of the IVFT system, the signs/symptoms will persist although perhaps somewhat reduced
9. an IV line, when present, should be regarded as a likely source of septicemia; when suspected, the cannula and all other components of the infusion should be removed immediately and the cannula tip cultured
10. cultures should also be done of the infusion fluid and blood, as well as the insertion site or of the cannula tip; the lot number of the suspected fluid should be recorded. If a positive culture is obtained, all fluid of the same lot should be removed from use, with local and federal authorities being notified to conduct an appropriate epidemiological investigation
11. when antimicrobial therapy is required, the final choice of drugs is based on culture and sensitivity results; until they are available, a combination of drugs effective against both gram negative and positive bacilli should be used

B. Suppurative Thrombophlebitis
1. one of most dreaded complication of IVFT, overall incidence is low
2. unlike regular thrombophlebitis, this type is characterized by a pocket of pus within the infected segment of the vein
3. the purulent matter containing vast numbers of organisms is carried throughout the blood, producing an overwhelming septicemia
4. the organisms most frequently associated with suppurative thrombophlebitis include resistant forms of gram negative bacilli, such as Enterobacter and Klebsiella and coagulase-positive Staphylococcus aureus
5. unless detected and treated surgically, the condition is generally lethal
6. a hindrance to early treatment is absence of local signs of inflammation or infection in as many as 70% of cases; thus many cases remain undetected until death occurs
7. as with any IV-associated infection, prevention must focus on absolute adherence to aseptic technique from cannula insertion throughout the duration of IV therapy
8. patients who have burns, are immune suppressed, or have cancer are especially at risk
9. signs/symptoms are essentially the same as septicemia with fever being major presentation; blood cultures are usually positive, as are cultures of the catheter tip; increasing white count is usually present
10. when these or other signs lead to suspicion of suppurative thrombophlebitis, exploratory venotomy should be done and appropriate treatment must be instituted immediately
11. the only definitive treatment is surgical excision of the affected segment of the vein and involved tributaries
12. broad coverage antibiotics should be initiated until culture results are available, at which time the antibiotic regimen should be changed as necessary; antibiotics and anticoagulants given in the absence of surgical intervention usually fail to eradicate the focus of infection and death frequently is the consequence

III. Preventive Measures (OSHA)

A. Occupational engineering controls may be instituted in individual facilities related to instruments, laboratory equipment, wastebasket liners, safety shields, sharps containers, recapping devices, specimen containers, closed trach suction systems, IV supplies (i.e. blunt or 'needleless' needles, adapter plug etc.)

B. Protective clothing and equipment which is designed to prevent patient body substances from reaching your clothing, skin, or mucous membranes. This clothing/equipment must be worn when any health care provider anticipates a work activity that could involve spraying, splashing, spattering or other contact with body substance. Any body substance, or fluid containing body substances, is to be considered potentially infectious. Protective clothing primarily consists of gown, face shields, and gloves. Use of any particular combination of these may be appropriate in a number of clinical situations.

C. The best and most consistent protection available is thorough and frequent hand washing.

D. Proper disposal of contaminated laundry and medical waste will need to be followed.

E. OSHA defines an occupational exposure incident as a specific eye, mouth, other mucus membrane, non-intact skin, or parenteral contact with blood or other potentially infectious material that results from the performance of an employee's duties.

F. Potentially infectious materials are defined as blood, semen, vaginal secretions, cerebral spinal fluid, peritoneal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid visibly contaminated with blood, unfixed tissues or organs from a person living or dead, or any HIV containing cell or tissue.

G. Standard precautions are practiced primarily to prevent contamination by blood borne diseases such as Hepatitis and HIV. Strict adherence to standard precautions can also help to prevent contamination from certain other viruses/bacteria such as cytomegalovirus, chickenpox, pertussis etc.

The geriatric client represents about 25% of the population, but consumes about 50% of all health care resources. It is the concern of all health professionals to provide quality care to this growing population.

I. Intravenous fluid administration to the geriatric population has shifted from the acute care setting to long term care facilities for the following reasons:
   A. cost of inpatient care and transfer costs of moving the client from one facility to the other
   B. the desire to decrease trauma to the geriatric client by not changing their environment too frequently or rapidly to limit confusion and disorientation

II. Appropriate terminology should be used regarding IVFT; older clients may associate IVFT with dying since in the 1930s and 1940s IVFT was reserved for only dying patients. Explanation should be given that the IVFT is used routinely now for a variety of reasons and definitely does not necessarily indicate seriousness of the client's condition.

III. Changes in the renal and circulatory systems in the elderly contribute to a decreased tolerance for rapid infusions. A rate not to exceed 80-100 cc per hour is generally recommended to create fewer complications.

IV. Elderly patients may be especially susceptible to nosocomial infections in a hospital setting and to depression and malnutrition in a nursing home setting.

V. These points are however helpful to keep in mind when administering IVFT to geriatric clients:
   A. Site selection in geriatric clients is more limited.
   B. Stability of the catheter/needle is an important consideration in geriatric IVFT.
   C. Strict attention to aseptic technique must be maintained because the geriatric client's immune system is more susceptible to infection. Signs and symptoms of infection may not manifest in the same manner as when the client was younger. The client may not have a fever, may have s/s of disorientation, confusion, loss of appetite, lethargy.
   D. Minimize use of tape directly on skin because excess taping can lead to skin tears when IV removed and decrease the potential for future insertion sites.
   E. The use of transparent dressing i.e. OP-Site or Tagaderm is recommended to cover insertion site with minimal taping over the transparent dressing.
   F. If the geriatric client is restless or agitated, long sleeves or elastic netting/gauze may be wrapped around IV site to keep needle/catheter in place. Placement of this gauze/netting should not be too tight to occlude the IV site or restrict circulation.
   G. The use of various types of restraints on the elderly client to decrease the chance of accidental removal of the IV is a controversial measure.
   H. IV Nursing Standards of Practice do not encourage wrapping anything completely around the IV site which can cut off circulation and/or restrict view of the site.
   I. For special problems with especially sensitive skin, certain dressing are manufactured which may be more soft, flexible, and comfortable to use. These types of dressings may also release from the skin more easily when removed, decreasing the chance of skin tears.
   J. Once therapy has been initiated, the elderly client may require reinforcement of patient teaching regarding IV therapy. Sensory changes in this type of patient may require the nurse to get the older person's attention, speak their name clearly, and touch them. This personal contact will probably increase the patient/resident's sense of security and comfort.

UNIT VIII: POTENTIAL INTRAVENOUS THERAPY COMPLICATIONS

LESSON 1: POTENTIAL LOCAL COMPLICATIONS: IV SITE ASSESSMENT

Assessment of an IV site is a very important aspect of caring for a patient during infusion. The infusion site should be inspected at least every hour. If the client is receiving added intravenous medication or blood products, the infusion site should be inspected more frequently, i.e. every 15-30 minutes.

To assess the site, the LPN needs to wash hands, identify the patient and explain what she/he is doing. If there is any drainage or moisture at the IV site or on the IV dressing, gloves must be worn before touching the site or dressing to protect the nurse from potentially contaminated blood and drainage.

I. The site should be checked for changes in the skin appearance that would indicate a problem:
   A. Edema/infiltration (fluid going into tissue)
      1. Second only to phlebitis as a major cause of IV problems
      2. Resulting tissue injury depends on
         a. clinical condition of patient
         b. type of fluid infusing
         c. volume (amount) infiltrated
      3. Damage may range from mild to serious.
      4. Once infiltration has occurred, fluid may continue to infuse until interstitial fluid pressure overcomes the gravity pressure of the infusion.
      5. The extent of tissue damage following an infiltrate is influenced primarily by the type of fluid infusing and the strength of medication.
      6. Osmolarity and pH have been found to be influential in producing differing amounts of tissue injury; therefore, higher osmolarity and larger volumes have been associated with greater tissue injury.
   B. Signs/symptoms of infiltration complication include:
      1. Infiltration
         a. swelling around the site
         b. marked coolness at the site
         c. site dressing becoming tight
         d. marked reduction in infusion rate
      2. Infection at site
         a. redness around site
         b. site is warm to tough
         c. discharge/drainage from site
      3. Allergic reaction to tape or dressing.
         a. rash at site, usually red
         b. blistering at site
         c. unusual pricking or burning sensation at site
      4. Thrombophlebitis (inflammation of vein with clot formation).
         a. sluggish flow rate
         b. edema in the limb with the I.V.
         c. the vein becoming sore, hard and Cord-like
         d. the site area becoming warm to tough
         e. a red line above infusion site which follows the path of the vein

C. If the above conditions exist, the procedures and their purposes include:
    1. Discontinuing the IV at that site (see procedure in this module).
    2. Applying warm moist compresses or towels to the site. This will increase the blood supply to the area, thereby bringing more oxygen, nutrients, and WBC's to the area to assist with fighting infection and increase tissue rebuilding. Increased circulation will also prevent further clot formation. No heat application for blood infiltration.
    3. Some studies recommend treatment with cold ice slush but warmth still seems to reduce the infiltrate at a faster rate.
    4. Possibly applying a topical antibiotic to the infected site to kill bacteria. The institution's policy manual and/or physician should be consulted before proceeding with this action.
    5. Never rub or massage an area or extremity that has thrombophlebitis, as a blood clot may become dislodged and the complication of pulmonary embolism may result.

Interventions must be done for the IV site problems to prevent the complications of tissue damage, which may result in tissue necrosis and death. If severe, tissue grafting and even amputation may be necessary. Many IV drugs cause extensive tissue damage quite quickly when they infuse into the tissue i.e. cancer drugs.

The LPN needs to document the site assessment in the nursing notes, stating where the site is, what the site looked like, any drainage or secretions noted and any pain or discomfort noted at the site.

Complications Resulting from IV Site Problems or Improper IV Administration Procedures

I. Systemic infections (see septicemia etc.)

II. Complication of air embolism may result if air is allowed to enter the tubing at any time during tubing/bag changes or administration of medications.
   A. Air that is introduced into the circulatory system may cause occlusion of blood vessel resulting in:
      1. cyanosis
      2. low blood pressure
      3. increase in pulse rate
      4. unconsciousness
   B. If the air emboli travels to the lungs, pulmonary emboli may result with signs of:
      1. dyspnea
      2. chest pain
      3. severe respiratory
      4. heart collapse

The IV needs to be turned off (clamped). Assess respiratory and circulatory status, monitor vital signs, and administer oxygen. Some sources say to turn patient onto left side to slow flow of air into the vein and allow air bubble to rise in right ventricle so that it does not enter pulmonary artery.

IV Drug Administration/Adverse Drug Response

I. Ways Drugs Are Used
   A. Diagnostic
      1. to determine function of an organ or organ system i.e. dyes given for intravenous renal and gallbladder studies
      2. to determine if there is an ongoing disease process in an organ system i.e. tuberculin skin tests
   B. Prophylactic
      1. Preventing communicable disease i.e. vaccine, antibiotics
      2. Preventing complications before surgery or after illness, injury or surgery i.e. lidocaine, antibiotics, heparin
   C. Therapeutic
      1. Curative: i.e. antibiotics, chemotherapy
      2. Palliative: i.e. narcotics, chemotherapy
      3. Supportive: i.e. anesthetics
      4. Replacement: i.e. electrolytes, vitamins, insulin

II. Pharmacokinetics
   A. Drug distribution
      Therapeutic drug concentration ranges may differ from patient to patient when the same dosage of the drug is given, even when factors such as size and age of patient are controlled for. One person taking the exact same dosage of medication may experience relief of signs/symptoms; while another may experience toxicity, and a third may experience no effect at all. Therapeutic drug concentration ranges exist for the commonly known drugs. Below the lower limit of the range, it is unlikely that the drug will exert maximum therapeutic effect. Above the higher limit of therapeutic range, toxicity is more likely to be present. Some drugs are actually less effective in concentrations above the upper limit of the therapeutic range. After being administered, drug must be delivered to the site of action
      1. Three factors control distribution:
         a. tissue perfusion (more richly perfused organs get greater amount of the drug); circulatory status of individual has an affect (i.e. in states of shock, impaired blood flow prevents meds from being delivered to tissues as rapidly as is desirable)
         b. plasma binding proteins: drugs in plasma are either free or bound to protein molecules found in plasma; these plasma binding proteins (i.e. albumin) can have an affect on a drug's ability to leave the bloodstream and interact with tissues; drug molecules bound to plasma albumin cannot diffuse into interstitial H_20 and become pharmacologically ineffective; the extent and variability of drug protein binding is important because only unbound drugs can cross membranes and interact with drug receptors to produce a therapeutic effect.
         c. lipid solubility: affects ability of drug molecules to cross cell membranes: lipid soluble drugs cross cell membranes easily; water soluble drugs experience difficulty in doing so.
      2. Unique settings for distribution
   B. Factors affecting blood levels of drugs
      1. drug dose; greater doses = higher blood levels
      2. bioavailability: two drugs given in identical doses to same individual-the one with greater bioavailability will produce higher blood concentrations; can also be defined as the fraction of an administered dose that reaches the systemic circulation.

3. volume of distribution: once drug has entered the body, it distributes throughout the whole body; a drug that has a large volume of distribution i.e. phenobarbital is said to distribute extensively while a drug that has a small volume of distribution i.e. Warfarin is said to have limited distribution; volume of distribution can vary from person to person and within the same person over time; knowledge of this value is more important than weight or body surface area in calculating loading doses or bolus doses of meds.
4. plasma protein binding-drugs bound to plasma protein will have higher blood levels than those not bound to albumin.
5. elimination via renal clearance-better the kidney functions, the grater will be the rate of elimination; clearance refers to disappearance of drug molecules from the plasma; clearance of any particular drug may be predominantly hepatic metabolism, predominantly renal elimination of unchanged drug or a combination of the two processes; common example is creatinine clearance which is of importance in use of some drugs i.e. Gentamycin
6. metabolism:
    a. having produced the desired effects, drug undergoes chemical alteration (biotransformation) which renders them active or inactive
    b. metabolism is used by tissues to detoxify foreign substances that accumulate in the body
    c. chemical reactions occur in the structure of the drug or compound so that it will be eliminated from the body through the kidneys, thus preventing their accumulation and subsequent overdosage or toxicity
    d. liver is primary site of metabolic enzymes with lesser contribution from lungs, kidneys, blood, G-I tract, skin, and placenta metabolism=age (neonate/elderly dosages may differ)
    e. drug molecules passing through the liver are metabolized so that they become vulnerable to further metabolic action or will be excreted in urine or bile
    f. metabolism occurs before a drug enters the systemic circulation as well as after
7. factors affecting response and therefore dosage given:
    a. body size: higher dose concentration noted with smaller persons; heavier (obese) persons will be better depositories of lipid soluble drugs than thin persons
    b. age: children and elderly
    c. genetic factors: i.e. identical twins metabolize drugs at fairly similar rates
    d. presence of disease processes
    e. route of administration
    f. interaction with other drugs given concurrently
8. Excretion
    a. kidney: primary organ of excretion, especially if drug is given IV; after being filtered through the glomeruli, part of the drug may be reabsorbed by the tubules; the amount actually excreted is in part affected by the degree of acidity or alkalinity of the urine
    b. in elimination process, chemical structure of molecules undergoing elimination are not changed; drugs and drug metabolites are eliminated primarily in the urine.
    c. biliary: some drugs or their metabolites are removed from the plasma by the liver and excreted into bile before passing into the duodenum
    d. a smaller portion may be eliminated in tears perspiration, breast milk, or breath

C. Drug interaction with target cells
    1. once the drug has been delivered to site of action, it acts biochemically to produce the desired response
    2. although all modes of action are not completely understood, it is believed that three general mechanisms operate:
        a. drug receptor interaction
        b. enzymatic effects
        c. general action at the cell membrane

D. Additional factors influencing pharmacokinetics are:
    1. half life
    2. steady state (maintenance/loading dose)
    3. drug receptors

E. Range of response
    1. Ineffective response: if less than the minimum required dose is given or if factors i.e. competitive antagonism by another drug interfere with its action-desired effect such as pain relief is not attained
    2. Therapeutic response: desired effects are produced
        a. for most drugs there is generally a range of doses & blood levels which produce the therapeutic effect-time required to achieve therapeutic effect is also variable.
        b. it is essential for the nurse to have some knowledge of the time frame in which a therapeutic response is expected so that the patient can be monitored to determine whether the drug has been effective
        c. to maintain therapeutic response, the dose administered within a given period of time must not exceed the rate at which it is metabolized and excreted
    3. Toxic response; should metabolism and/or excretion be impaired (as occurs in some liver/renal disease), or if an overdose is given, the drug will accumulate in the body, ultimately producing a toxic response
        a. toxicity may be manifested by an exaggeration of the usual pharmacologic actions of the drug or by signs/symptoms specific for that drug or class of drugs (see listing elsewhere in this module for untoward s/s)
        b. when administering any drug IV, the nurse should be aware of side effects of specific drugs/drug classes and untoward reaction; she/he should slow down the drug (if being given be continuous infusion) and notify the physician
        c. the most extreme toxic response, which can occur if a drug is given at a dose or rate far exceeding that recommended, is the lethal response: potassium chloride is a good example; if given too rapidly, or if administered as bolus, it will be fatal

III. Medication Information to be Obtained in a Nursing History

A. Drug allergies or sensitivities
    1. Previous problems with any drugs
    2. Previous problems with specific drug(s) to be administered
    3. Description of problems caused by drug(s)

B. Underlying health problems are important to the effects on circulation time of drug, utilization of a drug, dose of a drug, and type of drug ordered.
    1. Cardiovascular disease: in the patient with CHF, reduced cardiac output increases the circulation time of a drug. Renal failure can prolong the effect of digitalis preparations.

2. Renal disease: many drugs are excreted by the kidneys. Reduced kidney function means that it will take longer for the drug to leave the body. Renal failure prolongs effects of aminoglycoside antibiotics such as Gentamycin and may produce further renal damage.
3. Hepatic disease: liver failure can prolong the effects of Tylenol and anticoagulants.
4. Bleeding: anticoagulants are contraindicated if there is a history of ulcer.
5. Respiratory disease: Inderal is contraindicated if there is a history of asthma.

C. Individual's present drug use and use pattern
1. Names of all drugs now being taken (including OTC drugs)
2. Prescribed drug schedule
3. Personal drug schedule
4. Understanding of therapeutic reason for prescribed drug(s)

IV. Objectives to Determine about an IV Medication Before Administration
A. Average dose
B. Route of administration: some drugs may be administered by one or more routes; some drugs require a change in diluent when the route is changed. CAUTION: Make sure the specific preparation is given by its intended route i.e. Aminophylline, Librium
C. Length of time of injection or infusion
D. Expected action (effect)
E. Common untoward reactions (side effects)
F. Incompatibilities

V. The Five "Rights" of Administering Medications
A. Right medication
B. Right dose
C. Right route (method) i.e. SQ, IM, IV, PO
D. Right time
E. Right patient

VI. Safety measures when administering an IV medication: Some facilities prepare all piggyback medications in the pharmacy and then send a 24 hour supply to the unit, ready for administration
A. Check medication communication tool with patient's Kardex before preparing medications
B. Never give medication from an unlabeled or illegibly labeled container
C. Never give a medication without a doctor's order
D. Double-check any dose calculation with another nurse
E. Give only medications prepared by pharmacy, RN, physician
F. Identity patient before administering a medication
1. Call the patient by name
2. Have patient repeat his/her name to you
3. Verify the patient identity by checking the identification bracelet
G. Never leave a tray of medication unattended
H. Obtain nursing history with emphasis on drug allergies
CAUTION: Be very specific with drugs that can cause catastrophic reactions.
I. Read medication label three times
1st when taking from shelf or drawer
2nd when comparing medication with medication administration tool i.e. MAR
3rd before administering dose to patient
J. Always check IV needle or catheter and vein for patency before administering a medication (irrigating with saline/withdrawing for blood return)

K. Be sure than an appropriate label is affixed to an intermittent or continuous infusion container if medication is added. This label must contain the medication, dose, date, time, nurses' initials, patient's name, room number, and identification number.

VII. Methods of Administering IV Medications

A. IV push (beyond LPN scope of practice)

B. Intermittent infusion commonly termed IV piggyback or written IVPB on doctor's orders

1. Some drugs are more effective when a specific dose is given once, or repeated at intervals
2. Drug is added to a larger amount of solution
   A powdered drug is reconstituted with the proper type and amount of diluent in the vial and until clear, then drawn into a syringe and added to a larger amount of solution. The final dilution can vary from 50 ml. to 250 ml.
3. Administered through an alternate IV administration set i.e. secondary tubing into secondary port or back-check valve port; volume control device
4. Administered over a longer period of time than direct injection i.e. 15 minutes to several hours initially producing a peak blood level which tapers off before the next dose is given
5. Methods in use:
   a. piggy back method
      1. for majority of drugs given by intermittent infusion, 50 or 100 ml. of fluid is recommended to dilute the drug
      2. partially filled glass bottles and plastic containers are available with those volumes of the fluids most commonly used for dilution-there is sufficient space in these containers to allow the addition and mixing of the drug
      3. except for their small size, these containers are like the standard sized bottles/bags insofar as adding the drug and attaching the admin. set
      4. the preferred piggyback technique involves the use of a primary admin. set which incorporates a check valve or clamp just above the Y-injection port, allowing either automatic (valve) or manual (clamp) shutoff of the primary fluid while the medication is infusing and either automatic or manual resumption of the primary
      5. to administer a dose of medication, the following procedure is followed:
         a) using aspetic technique, attach a secondary admin. set to the container with the medication, and attach a needle to the end of the set
         b) suspend the secondary container 6-8 inches above the primary container by means of an extension hook
         c) after clearing the tubing of air, cleanse the injection site of the primary tubing with betadine or alcohol and insert the needle
         d) adjust the flow rate of the secondary bottle (med) by means of the single flow clamp located below the injection site
      6. after the secondary container has infused, either the automatic shut off valve will open to the primary infusion set to allow fluid to flow again from the primary bag/bottle or the nurse will need to manual shut off the secondary set with the slide clamp and open the primary set up with a roller clamp and hang the primary bag back to its original position
      7. flow rates will more than likely need to be adjusted because the medication will probably not be infusing at the rate that the primary IV set was infusing
      8. once a dose has been administered, the secondary container and tubing can be discarded; or if it is to be used for subsequent doses, it is kept attached to the secondary bottle/bag to keep the line sterile

9. when the next dose is due:
    a) re-prime the secondary tubing by closing the flow control clamp and lowering the empty secondary container, allowing fluid from the primary container to fill the tubing and proceed halfway up the drip chamber
    b) prepare the container with the next dose of medication
    c) using aseptic technique, remove the piercing pin from the empty container and insert into the new secondary container
    d) suspend the secondary bottle and open the flow clamp to establish flow
10. the piggyback method uses a separate fluid container for each dose of medication and thus is somewhat more expensive, but the risk of contamination is reduced
    a) Heparin lock infusion sets:
        1. repeated doses of an IV drugs such as heparin or antibiotics may be required for a patient who does not need an IV line for the continuous infusion of either fluids or drugs-for such patients, the insertion of an intermittent infusion device, know as a heparin lock is desirable
        2. prepare the dose of medication and add to either a partially filled fluid container and set up as described previously
        3. cleanse the rubber injection site on the heparin lock with alcohol or betadine
        4. insert a syringe and needle filled with 1-2 ml of normal saline into the site and aspirate until a flashback of blood is seen, verifying position of the cannula within the vein
        5. continue infusing the normal saline (if blood return is noted) into the heparin lock to flush the line from previous heparin dose
        NOTE: occasionally blood return will not be seen but if IV line flushed appropriately, patency of the vein is assumed to be intact- if unable to flush IV line a new line may need to be started.
        6. remove the needle that was used to flush the line and insert needle from the end of the admin. set
        7. adjust the flow control clamp until and desired rate is maintained
        8. return to check the infusion periodically to insure that the bottle/bag is not allowed to run completely dry in order to avoid air embolism-if infusion sets is on an IV pump, appropriate flow rate and volume will be set so pump will alarm when appropriate volume has been infused
        9. when medication has finished infusing, again flush the line with another 1-2 ml. of normal saline to flush antibiotic from the tubing
        10. remove this needle and syringe and infuse an appropriate dose of heparin, or heparinized saline to keep the line open until the next dose

C. Continuous infusion of medications
    1. LPN responsibility with continuous infusion will be to assist with monitoring rate, drip factors, tubing and equipment functioning once solution and or medication added has been mixed by a pharmacist, RN or physician

VIII. Advantages/Disadvantage of IV Medication Administrations

A. Advantages/Uses
    1. Absorption is immediate with IV route; used when p.o. route is unacceptable for a variety of reasons such as patient intolerance of p.o. route, irritation to GI tract, or drugs which are inactivated by GI secretions
    2. Advantages of this route of administration include:
        a. immediacy of effect (essential in life threatening situation)

b. predictable blood levels of drug
c. rapid modification of the drug dose because total dose is absorbed, precise dosage calculation & flow rates can be achieved-dose can be titrated to sustain continuous control of therapeutic response-should an adverse reaction occur during administering the remainder of the dose can be instantly discontinued

3. Preferred route for patients in shock, however, although effect of drug is very rapid, an incorrect calculation of the dose can lead to immediate toxicity

B. Disadvantages
1. Once a medication has been given it cannot be recalled and its effects sometimes not reverse—since untoward reactions can occur with the same rapidity as the desired response, unexpected effects can be serious and sometimes fatal
2. IV drug administration presents the risk of additional complications, particularly infection. Aseptic techniques must be faithfully adhered to
3. Venipuncture requires considerable degree of skill which limits the group of nurses and other health professionals who can perform it-even when the med is to be given into an established IV line, limitations on specific drugs, and modes of admin. Etc. are often established by state law and institutional policies
4. Even when performed skillfully, IV cannula insertion and drug administration are not without some discomfort
5. Depending on patient's age, past experience and psychological status, it can be a source of emotional trauma

IX. Nursing Responsibilities and Interventions Regarding Administration of IV Medications
A. Follow closely all of the "Five Rights" when administering medications
B. Obtain or find where to obtain reference material for each medication with reference to dosage, routes, method or mode, length of infusion or injection, incompatibilities, effects, and side effects or untoward reactions. Several reference books may be consulted. Recommendation is made for Intravenous Medications: A Handbook for Nurses and Other Allied Health Professionals by Betty L. Gahart, and the standard PDR or Physician's Desk Reference – a copy can be found in most institutions.
C. Obtain nursing history with emphasis on allergies
D. Choose appropriate syringe or IV tubing
E. Always tape any connections in IV line
F. Check insertion site before administration of meds for signs of infiltration/phlebitis
G. Observe patient for desired effects and any side effects or untoward reactions
H. Use strict aseptic technique throughout preparation and administration of medications
I. I. Instruct patient/family on medication use, side effects etc. Repeat instructions as necessary. If multiple drugs are being utilized, instruct on any interaction effects etc.

X. Effects of Drug Incompatibilities
A. Undesired physiochemical reaction i.e. Demerol added to Valium will cause release of a gas
B. Instability of drug i.e. stability destroyed by exposure to light, storage at improper temperature, diluent being added to powdered drugs. A drug is considered stable if at least 90% of its properties are effective until a specific time or date. CAUTION: When a drug is in a colored or dark vial, it should be considered light-sensitive and protected from any lengthy exposure to strong, bright light.
C. Possible destruction of drug's therapeutic action

XI. Types of Drug Incompatibilities
  A. Physical incompatibility
    1. Therapeutically ineffective action i.e. Valium combined in a syringe with any other drug
    2. Precipitation, color change, gas release (bubbles), or cloudiness. Color change occurs when a drug experiences an electron or hydrogen loss, or an oxygen increase
    3. Inadequate soluablities or acid/base reactions
  B. Chemical incompatibility
    1. Therapeutically inactive drug i.e. Gentamycin is inactivated if given within 2 hours of Geopen
    2. May not be visible
    3. Irreversible breakdown of drug

XII. Factors that Affect Compatibility
  A. Concentration of drug or drugs
    1. The stronger the drug in solution, the quicker it can become incompatible or unstable
    2. Multiple drugs in solution can become incompatible or unstable quickly
  B. Length of contact time: CAUTION: Prepare medications just before administration.
    1. The longer a drug is reconstituted, the greater the chance of it becoming incompatible or unstable
    2. The longer a drug is in solution, the greater the chance of it becoming incompatible or unstable
  C. Temperature of solution
    1. High temperature promotes instability and incompatibility
    2. Low temperature provides stability and less chance of incompatibility. Most powdered drugs have an expiration time after the diluent is added. Check to see if a reconstituted drug requires refrigeration for stability.
  D. pH level of mixture
    1. Adding a diluent to a drug can change pH level
    2. Adding a drug to a solution can change pH level i.e. Aqueous Penicillin requires an acid solution; Erythromycin requires a more alkaline solution. CAUTION: Many drugs require either an acid or alkaline environment for stability.
  E. Light sensitivity
    1. Exposure to light can result in degradation of some drugs i.e. Lasix, vitamin preparations
    2. Colored vials or ampules are a clue to light sensitivity. Some drugs, such as Nipride, come with foil to cover the solution after it is mixed.

XIII. Reason for Using Buffers with IV Medications: To raise the pH of the IV solution before certain medications are added to the solution.

CAUTION: Because only certain medications require the increased pH, it is absolutely necessary that the nurse check medication package inserts to determine if a buffer is required.

XIV. Nursing Responsibilities and Interventions with Regard to Avoiding Incompatibilities
  A. Refer to all available resources and IV texts to determine and avoid incompatibilities.
  B. Always check medication package insert to determine whether a buffer is required.
  C. Always mix solutions well.
  D. Monitor for physical signs of incompatibilities i.e. color change, cloudiness, crystals. i.e. Dilantin is compatible only with normal saline and will precipitate when in contact with any other solution or drug; Valium is compatible only with blood and will cloud when in contact with any other drug or solution.
  E. Schedule drugs carefully. When scheduling multiple drugs, the possible incompatibilities must be considered and the drugs scheduled with sufficient time for complete infusion and clearance of tubing between drugs.

XV. Terms Associated with Untoward Reactions

A. Angioniurotic edema – a condition characterized by development of local allergic hives and generalized swelling. This condition is benign and thought to be an allergic disorder.
B. Anorexia – Lack of appetite
C. Antibody – Protein produced in the body in response to contact of the body with an antigen; neutralizes the antigen
D. Antigen – Substance that causes production of an antibody
E. Anuria – No urine output
F. Apnea – Absence of respirations
G. Bradycardia – Slow heart rate
H. Dyspnea – Difficulty breathing
I. PVC's – Premature beats that can originate anywhere in the heart
J. Hematuria – Blood in urine
K. Hemolysis – Destruction of red blood cells
L. Ion-Electrically charged particle that can give off that charge when dissolved in water
M. Necrosis – Death of tissue
N. pH Expression of acidity or alkalinity
O. Pruritus – Severe itching
P. Solubility – Capability of being dissolved
Q. Susceptible – Easily influenced by or affected with
R. Tachypnea – Rapid respirations
S. Tachycardia – Rapid heart rate
T. Threshold – Point at which a stimulus is just strong enough to be perceived
U. Tolerance – an ability to endure or resist the effects of something
V. Tremors – Trembling, shaking
W. Urticaria – Vascular skin reaction characterized by hives and associated with severe itching
X. Ventricular fibrillation – Chaotic, uncoordinated quivering of heart
Y. Ventricular tachycardia – Very repaid heart rate in which the impulse causing the beating is coming from the ventricle

XVI. Types of Untoward Reactions and/or Side Effects

A. Tolerance
    1. Increasing amounts of drug are needed to produce desired effect
    2. Usually occurs when a drug is given over a long period of time
    3. Occurrence of cross tolerance can develop with chemically related drugs. If tolerance has developed to a narcotic such as Demerol, a cross tolerance to another narcotic such as Levo-dromoran may occur.
B. Accumulation
    1. Occurs when a drug is given at a faster rate than it can be metabolized and excreted. As each dose if given, more of the drug accumulates and a toxic effect will occur.
    2. Occurrence can be influenced by ongoing disease processes. These diseases are usually heart, liver and renal in nature. Drugs that most frequently cause accumulation are narcotics and anticoagulants.
C. Intolerance (hypersusceptibility)
    1. Occurs when there is a greater response than normal
    2. Occurs when the threshold to normal action is lowered. A drug that frequently causes intolerance is digoxin.
D. Idiosyncrasy: Unpredictable response that is different from desired response
    1. Occurrence not due to an allergy; often occurs with the class of drugs know as sedatives

E. Drug allergy (hypersensitivity)
   1. Causes only a small percentage of untoward reactions
   2. Occurrence requires a prior exposure with a lapse of ten to fourteen days. This lapse is necessary for the antigen-antibody process to develop.
   3. Signs are: skin reactions, fever, dyspnea, tightness in chest, nausea and/or vomiting, bronchospasms, laryngeal edema, and drop in blood pressure.
   4. Can lead to shock, circulatory collapse, and death.

F. Overdose
   1. Causes largest percentage of untoward reactions
   2. Usually accidental
   3. Occurrence can be due to a preexisting health problem
   4. Frequently related to time and/or rate of injection

XVII. Body Systems Affected by Untoward Reactions

A. Central nervous system. Effects include:
   1. stimulation
   2. restlessness
   3. tremors
   4. convulsions
   5. depression
   6. drowsiness
   7. slurred speech
   8. coma

B. Blood vessel and vascular system. Effects include:
   1. vasodilation with resulting hypotension and shock
   2. vasoconstriction with resulting hypertension and possible cerebral vascular accident or peripheral necrosis.

C. Cardiac effects include:
   1. bradycardia
   2. tachycardia
   3. PVC's
   4. ventricular tachycardia
   5. ventricular fibrillation

D. Pulmonary effects include:
   1. dyspnea
   2. tachypnea
   3. apnea
   4. acute asthmatic attack
   5. ventricular fibrillation

E. Mucous membrane and skin effects include:
   1. pruritus
   2. urticaria
   3. apnea
   4. ventricular tachycardia
   5. laryngospasms

F. Gastrointestinal effects include:
   1. nausea and/or vomiting
   2. anorexia
   3. intestinal cramping
   4. diarrhea

G. Liver and hepatic system effects include:
   1. acute hepatic necrosis
   2. Jaundice

H. Blood and blood forming organs effects include:
   1. Hemolysis
   2. bone marrow depression
   3. cellular malformation

I. Urinary tract effects include:
   1. urine retention
   2. anuria
   3. hematuria

XVIII. Nursing Responsibilities and Interventions with Regard to Untoward Reactions

A. Monitor all body systems for signs of untoward reactions. Stay with the patient during the first five to fifteen minutes of the infusion of a drug.
B. Know which drugs are more likely to cause life-threatening reactions i.e. Penicillin and its derivatives, cephalosporins, Dilantin, and diagnostic dyes.
C. Identify susceptible patients through a nursing history.
D. Avoid accidental dosage errors
E. Utilize resource material and follow guidelines for rate of injection/infusion.
F. Enlist patient's help and cooperation. Instruct patient to call if experiencing any of the signs of an allergic reaction such as hives, itching, dyspnea, or swelling of the face.
   CAUTION: Try not to alarm the patient.
G. Stop infusion of drug immediately if allergic reaction is suspected. Change the main solution and tubing if medication is in the solution. Change tubing if medication is by secondary set.
   CAUTION: Keep the vein open. It may be your patient's only lifeline.
H. Call for help and have another nurse stay with patient if any type of severe reaction occurs.
I. Notify doctor immediately if allergic reaction is suspected.
J. Monitor vial signs as indicated by type and seriousness of reaction
K. Reassure patient and family
L. Initiate resuscitation of reaction is catastrophic
M. Document your observations, actions and any treatments initiated

Actions, Uses, and Common Side Effects

I. Antimicrobial Agents: Antibiotic, antifungal, and antiviral agents are frequently administered via IV. Antibiotics act either by inhibiting bacterial cell wall synthesis and producing a defective cell wall, or, by altering intracellular function of the bacteria for example, electron transport, target DNA binding. The categories of antimicrobial agents most widely used are:

A. Penicillins
   1. Mechanism of action: inhibits bacterial cell wall synthesis.
   2. Targets most gram-positive organisms (staph, strep, pneumococci, clostridia, hemophylus influenza) and some gram-negative cocci (gonococci and spirochete causing syphilis)
   3. Adverse reactions: It is estimated that up to 15% of the population is allergic to penicillin.
      a. GI symptoms, esp. diarrhea
      b. Hypersensitive reactions
      c. Renal damage
      d. Anaphylaxis: rash, pruritus, laryngeal edema, wheezing
   4. Excreted by kidneys
   5. Some names of drugs
      a. Penicillin G
      b. Ampicillin
      c. Nafcillin
      d. Unasyn
      e. Ticarcillin

B. Cephalosporins: widely used, relatively safe antibiotics. There is a wide dosage range between toxic drug levels and subtherapeutic drug levels. Most cephalosporins are destroyed by acid medium of stomach and must be administered IV. Cephalosporins are often used to treat UTI's strep pharyngitis, surgical wound infections, gram negative sepsis, meningitis, and soft tissue/intra abdominal infections. Individuals with penicillin allergies may also be sensitive to cephalosporins.
   1. Mechanism of action: are bactericidal with actions and structures similar to penicillin.
   2. Target organisms:
      a. First generation: Most gram-positive organisms and some gram-negative organisms.
      b. Second generation: Increased gram-negative action, decreased gram-positive effectiveness.
      c. Third generation: Expanded gram-negative coverage, decreased gram-positive coverage.
   3. Adverse reactions:
      a. Hypersensitivity
      b. Phlebitis
      c. Diarrhea
      d. Neutropenia
      e. Altered liver function

      NOTE: Aminoglycosides are chemically inactivated by cephalosporins.
   4. Rapidly excreted by kidneys. so must be administered frequently to maintain adequate blood levels.
   5. Some names of drugs:

First generation:	a. Cefazolin (Ancef)		
Second generation:	a. Cefotan	b. Mefoxin	c. Zinacef
Third generation:	a. Cefobid	b. Claforan	c. Rocephin

C. Aminoglycosides: used most often to treat bacteremia, systemic infections, and urinary tract infections. IV administration is always used, since these are not absorbed from the GI tract.
   1. Mechanism of action: interference with bacterial protein synthesis and replication. Bacteriocidal in nature.
   2. Target organisms: a. gram-negative aerobes b. staphylococci c. mycobacteria
   3. Adverse reactions
      a. Toxicity: is a concern when using aminoglycosides because of the narrow range between therapeutic and toxic effects. To monitor drug dosages closely, periodic drug peak and trough levels are drawn.
      b. Nephrotoxicity: persons who already have diminished renal function are especially at risk for developing this effect.
      c. Ototoxicity: Tinnitus, loss of high frequency hearing, and altered balance may result. Diuretics (Edecrin and Lasix) potentiate nephrotoxicity. 8th cranial nerve damage is the cause of hearing and balance problems.
      d. Neuromuscular blockade: Respiratory depression or paralysis can occur in conjunction with anesthetics.
   4. Excreted by kidneys. Dosages must be decreased in neonates or adults with reduced renal function.
   5. Some names of drugs:
      a. Amikacin
      b. Gentamycin
      c. Neomycin
      d. Tobramycin

II. Potassium (K)

Hypokalemia, serum K less than 3.5 mEqL, is treated with oral or IV administration of potassium chloride (KCL). A potassium deficit is slowly corrected to avoid development of transient hyperkalemia, serum K greater that 5mEqL. Indications for use are prophylaxis or treatment of K deficiency. Some guidelines for IV use are as follows:

A. Soluble in all commonly used IV solutions. In severe hypokalemia, solutions without dextrose are preferred (dextrose might decrease serum K level).
B. Maximum of 10 mEq per hour KCI in any given amount of infusion fluid should not be exceeded.
C. Each individual dose must be diluted in 500 to 1000cc of IV infusion.
D. KCI should be thoroughly mixed when adding to IV solution to avoid layering of potassium at the bottom of the gag. Do not add K to an IV bottle/bag in the hanging position.
E. KCI should never be administered directly in a concentrated form by IV push because of the danger of cardiac arrest.
F. If the administration rate exceeds 20 mEq/hour, cardiac monitoring is suggested.
G. Urine output of at least 30 ml/hr should be verified before beginning IV potassium administration.
H. A low dose of lidocaine may be added to the KCI solution to decrease the burning sensation patients may complain of when IV infusions contain greater than 40 mEq/L.
I. Other medication considerations:
   1. Aldactone will potentiate the effect of K
   2. Digitalis intoxication may occur with hypokalemia (use with extreme caution in pts taking Digitalis).
   3. Thiazide diuretics cause hypokalemia
J. Nursing considerations:
   1. Monitoring of routine K, CA and NA Levels, pH and EKG's are suggested.

2. Monitor I & O closely. Adequate hydration and evaluation of adequate urine output are mandatory.
3. Continuous cardiac monitoring is preferable for infusion of over 10mEq of KCL in one hour.
4. Confirm absolute patency of vein as extravasation will cause necrosis.
5. Be aware that pain/burning at the site of infusion may not be phlebitis. Applying warm compresses may help.

III. Vitamins

Vitamins function as essential cofactors in a number of enzymatic processes and cannot be manufactured within the body. Actual IV vitamin requirements are considered greater than oral requirements because of increased renal excretion and absorption of vitamins to IV bags and tubings. Most vitamins will be given in combination with TPN (total parenteral nutrition).

A. Usually ordered as MVI (multivitamin). Example: 1amp MVI to every other liter.
B. Vitamin C can be given undiluted or administered diluted in IV solution. It is less effective when given IV but has few side effects.
C. Vitamin B is rarely given IV and is usually given as a multiple B vitamin.
D. Vitamin K is not included in most commercially prepared IV vitamin solutions because of the possible adverse effects in patients taking oral anticoagulants.

IV. Heparin/Heparin Flush

Heparin is an anticoagulant with immediate and predictable effects on blood. Heparin combines with other factors in blood to inhibit the conversion of prothrombin to thrombin and fibrinogen to fibrin. Adhesiveness of platelets is reduced. Well established clots are not dissolved but growth is prevented and newer clots may be dissolved. Duration of action is short, about 4-6 hours. Actual average half-life is about 60-90 minutes; half-life is prolonged by higher doses. Heparin is metabolized in the liver and excreted by kidneys.

A. Dose can vary from 10 to 1000 units/ml.
   Read label carefully as heparin comes in many strengths and unit to mg. conversions are not consistent.
B. May be administered undiluted or diluted with 0.5 to 1 ml of normal saline.
C. Frequently
   1. after each medication infusion
   2. or every 8-12 hours if IV needle/catheter is being kept open for other uses i.e. X ray.

Heparin Flush is used to maintain patency of an IV needle/catheter without a continuous IV infusion. Continuous IV heparin infusion is not covered in this module. Consult IV drug books if necessary to administer continuous heparin drip.

CLINICAL REVIEW CHECKLIST

HANGING PRIMARY IV SOLUTION

Procedure
1. Perform proper handwashing.
2. Check patient's chart for correct solution.
3. Check Kardex/Communication Tool for correct solution.
4. Select correct solution.
5. Inspect solution for clarity.
6. Check IV bag for leaks.
7. Check expiration date on container.
8. Calculate correct drop factor for IV to infuse or set IV pump at correct rate.
9. Check patient identification band.
10. Explain procedure to patient.
11. Hang IV solution by spiking container to maintain sterility.
12 If necessary to change tubing, fill primary tubing (single or multiple injection port) appropriately being careful to avoid tough contamination.
13 Select correct drop factor for IV to infuse or set IV pump at correct rate.
14. Document on appropriate form i. e. IV flow sheet.

CLINICAL REVIEW CHECKLIST

SET UP PIGGYBACK ADMINISTRATION SET INTO SECONDARY PORT

Procedure
1. Perform proper handwashing.
2. Check order for proper medication to be administered.
3. Check patient MAR for proper medication, route and time.
4. Calculate rate of medication administration.
5. Check patient identification band.
6. Fill piggyback tubing (single or multiple injection port) removing air using appropriate methods.
7. Insert piggyback administration set into secondary port using sterile technique.
8. If gravity drip, low primary IV solution 6-8 inches below secondary bottle/bag. If IV pump infusion, clamp off primary tubing.
9. Adjust flow rate for piggyback infusion.
10. Sign off medication on MAR.
11. After piggyback has infused, clamp off and resume primary infusion as before.

CLINICAL REVIEW CHECKLIST

CONVERTING CONTINUOUS IV INFUSION TO A HEPARIN LOCK

Procedure
1. Perform proper handwashing.
2. Check physician order for heparin lock.
3. Open packaging containing heparin lock device.
4. Remove from packaging and inspect it for flaws.
5. Fill 3cc syringe with normal saline.
6. Cleanse intermittent injection cap with alcohol/betadine.
7. Insert syringe into cap and fill heparin plug and/or attached tubing with normal saline.
8. Fill second syringe with appropriate flushing medication (i.e., 10 units of Heparin)
9. Verify proper patient identification.
10. Explain procedure to patient.
11. Put on gloves and proceed to detach IV tubing nearest the needle insertion device.
12. Screw heparin lock device onto tubing attached to needle insertion device.
13. Clean latex injection port on heparin plug with alcohol/betadine.
14. Slowly inject heparin lock device with appropriate anticoagulant solution.
15. Secure heparin lock device with appropriate tape, Kerlix, or armboard as necessary according to patient need.

CLINICAL REVIEW CHECKLIST

ADMINISTRATION OF MEDICATION THROUGH A HEPARIN LOCK

Procedure
1. Perform proper handwashing
2. Check patient MAR for correct medication to be delivered and verify rout, volume, dose, patient.
3. Fill one 3cc syringe with 1-2 cc normal saline.
4. Fill second 3cc syringe with 1-2 normal saline.
5. Fill one 3cc syringe with appropriate anticoagulant solution (if needed).
6. Assemble supplies and medication and take to patient's room.
7. Explain procedure to patient/family.
8. Prime tubing set for attachment of piggyback medication, being careful to avoid touch contamination.
9. Put on gloves is any contact with body fluids is suspected.
10 Verify proper patient identification.
11. Visually inspect IV site before injecting saline or medication (if any signs of infiltration/infection, notify RN to check the site).
12. Cleanse heparin lock latex injection port with alcohol/betadine.
13. Slowly inject first syringe of saline into latex heparin injection port to clear tubing and heparin plug watching closely for any signs of infiltration.
14. Attach piggyback medication by inserting needle into center of heparin latex injection port.
15. Calculate the correct drop factor for medication to infuse or set IV pump at correct rate.
16. Check medication frequently during infusion to ensure the bottle/bag is not allowed to run completely dry.
17. Upon successful infusion of piggyback medication, cleanse heparin plug with Alcohol/betadine and flush intermittent injection cap and attached tubing with second Syringe of saline.
18. Remove this needle and slowly inject the appropriate amount of anticoagulant solution.

CLINICAL REVIEW CHECKLIST

DISCONTINUATION OF AN IV OR HEPARIN LOCK

Procedure
1. Check doctor's order for discontinuation of IV.
2. Check chart for type and length of needle that was inserted.
3. Assemble equipment 9cotton ball/sterile 2x2 sponge, antiseptic band-aid, ointment.
4. Identify patient and explain procedure.
5. Perform proper handwashing. Put on gloves to protect self from potential body fluid contact.
6. Stop the flow of infusion by turning the clamp completely off.
7. Apply tourniquet above the insertion site if institution policy so directs.
8. Loosen and remove all tape, IV dressing, and other securing device.
9. Place sterile gauze or cotton ball over the needle insertion site, apply gentle pressure.
10. Remove the IV needle/catheter following the path of insertion. Apply more pressure to the insertion site.
11. Assess that the IV needle/cannula is completely intact. If it is not notify RN immediately.
12. When bleeding at site has stopped or decreased, remove the gauze or cotton ball and apply antiseptic ointment prior to taping if appropriate.
13 Discard the needle, tubing, and solution container appropriately.
14. Remove gloves. Wash hands.
15. Assess site several times during the next 30 minutes for any bleeding. Instruct patient to call if bleeding resumes.
16. Document in nurses' notes and/or IV flow sheet: a. time, site type of needle removed b. reason for discontinuing IV c. condition of catheter/needle (intact) d. assessment of site and other responses of patient (if appropriate) e. amount of solution infused (also on I & O)

CLINICAL REVIEW CHECKLIST

INITIATION OF PERIPHERAL INTRAVENOUS INFUSION

Procedure	
1.	Review physician's orders.
2.	Wash your hands.
3.	Choose appropriate equipment.
4.	Set up IV fluid and tubing.
5.	Take equipment to bedside.
6.	Identify patient.
7.	Prepare patient psychologically.
8.	Adjust lighting.
9.	Prepare patient physically.
10.	Wash your hands and put on gloves.
11.	Select position of comfort for yourself.
12.	Locate vein. Apply tourniquet.
13.	Release tourniquet.
14.	Clean area thoroughly.
15.	If policy is to anesthetize area, do so now.
16.	Reapply the tourniquet.
17.	If using a device with a catheter, inspect for defects.
18.	Insert needle and advance cannula.
19.	Release tourniquet.
20.	Connect tubing and initiate flow.
21.	Remove gloves, tape cannula, dress site.
22.	Adjust flow rate.
23.	Care for equipment.
24.	Wash hands.
25.	Evaluate using the following criteria: A) Right patient, right solution, right time, right amount, right rate, correctly documented. B) IV secure C) Patient comfortable
26.	Document IV insertion on appropriate chart forms.

CLINICAL REVIEW CHECKLIST

CENTRAL LINE DRESSING CHANGE

Procedure
1. Gather supplies.
2. Cleanse the table that will be used to establish the sterile field with alcohol or other 3. disinfectant. Allow to dry.
4. Apply a mask. Instruct the patient to apply a mask, or turn the patient's head to the side opposite the insertion site, according to facility policy.
5. Wash your hands.
6. Using the sterile drape, set up the sterile field. Open packages of sterile supplies, placing them on the sterile field. Avoid turning your back on the sterile field.
7. Apply disposable exam gloves and remove the soiled dressing. Discard in the plastic bag. Keep the soiled dressing and the plastic bag well away from the sterile field. Avoid reaching over the field to discard the dressing.
8. Remove gloves and discard in the plastic bag.
9. Wash your hands.
10. Cleanse the skin with the providone-iodine applicators, three applicators are needed to cleanse the skin for this procedure. Discard used applicators in plastic bag.
11. After skin dries, use gauze or transparent dressing to cover the insertion site. Secure with tape if a gauze dressing is used.
12. Remove your gloves and mask. Assist the patient to remove mask, if necessary.
13. Remove used supplies and discard according to facility policy.

LPN ROLE INPARENTERAL THERAPY ADMINISTRATION:

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